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THE ENGINEERING MAGAZINE

AN INDUSTRIAL REVIEW

EDITED BY JOHN R. DUNLAP.

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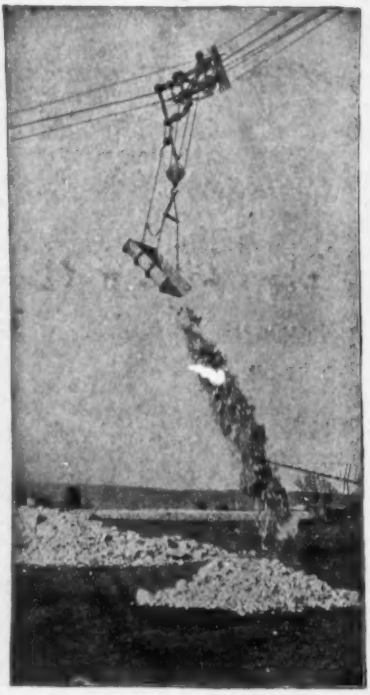

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THE

ENGINEERING MAGAZINE

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REPRESENTATIVE MONEY AND GOLD EXPORTATIONS.

*By Horace White.**

REPRESENTATIVE money is anything promising to pay money, which circulates as a common medium of exchange. It is usually made of paper, but sometimes of a cheap metal. When it is issued by a government, and is legal tender, it is called fiat money.

Money, as we have seen, is an instrument of exchange. There may be too many or too few of these instruments at any time or place, as there may be too many or too few carts or wheelbarrows. When the money is a commodity of general use in the world, like the precious metals, then, if any country has more than it needs, there will be an exportation of the surplus; if less, there will be an importation. This movement is automatic. It is as certain to take place as an exportation of grain when there is a surplus, or an importation when there is a shortage. Nobody, not even the government, can prevent it.

Now let us see what happens when the government forces its own notes into circulation. Suppose that one million dollars was just enough before, and that the government adds one hundred thousand. If the conditions of trade and industry remain the same, there will now be one hundred thousand too many instruments of exchange, and the surplus will be exported. Since foreigners will not take the paper, the exported instruments will be the metallic ones.

Suppose that the government issues one hundred thousand dollars more. The surplus cannot be exported, because foreigners will not

*This is the second of the two articles designed to indicate, by selected quotations, the outline of Mr. Horace White's argument in his admirable book entitled "Money and Banking." The preceding article, entitled "First Principles and the Gold Standard,"

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take it. The goods and property in circulation were formerly measured by one million dollars. They are now measured by twelve hundred thousand. Prices will rise. This means that the currency is now depreciated. It will probably be depreciated rather more than the quantity would indicate, because people will expect further issues and will anticipate them by charging more for their goods. Those who are receiving fixed incomes, whether wages, salaries, or interest, will be cheated, because the things they buy will cost more, while their receipts will be no greater. Uncertainty will be introduced into business. The investment of capital will, for this reason, be retarded, while speculation will be promoted.

The first government paper money in this country was issued by the colony of Massachusetts in 1690, in order to pay soldiers who had returned without their expected booty from an expedition against Canada. The general court issued £40,000 in due bills, which were made receivable for taxes and exchangeable for any commodities in the treasury. In 1692 the bills were made legal tender in all payments, and receivable for taxes at five per cent. better than silver and redeemable in silver at the end of twelve months. These provisions made them equal to silver.

It was a fatal experiment. Its apparent success as a means of postponing taxes led to disorders far worse than the commodity currency of the earlier period. No kings, however tyrannical, ever debased the money in circulation so recklessly, persistently, outrageously, as the colonial assemblies.

Contemporary history tells us that these sins were not committed through ignorance. It was not through ignorance that Massachusetts, for example, watered her currency till one pound sterling would buy eleven pounds of paper money, and then repudiated all but one-fifth of it.

Thomas Paine tells us how the speculators and debtors were then working for bills of credit. He says:

> There are a set of men who go about making purchases upon credit, and buying estates that they have not wherewithal to pay for; and, having done this, their next step is to fill the newspapers with paragraphs of the scarcity of money and the necessity of a paper emission, then to have legal tender under the pretence of sup-

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appeared in our December number, and it should certainly be read by everyone who reads this one.

We have before referred to the rare excellence of this book. The simple truth is that, in a compact and most entertaining little volume, it gives the whole history of money and banking in the United States, from the earliest settlement of the American continent to date; and, using the familiar events of our financial history as illustrations of the principles of monetary science, it makes the whole subject so perfectly clear that every reader can comprehend. In view of the present and pressing importance of the money question in the United States, it is a book which every man of intelligence and influence should read. Published by Ginn & Co., Boston; price, $2.

porting its credit, and, when out, to depreciate it as fast as they can, get a deal of it for a little price, and cheat their creditors; and this is the concise history of paper-money schemes.

Bad as the colonial fiat money was, that of the revolutionary period was worse. Even Franklin, who had been a pronounced greenbacker in earlier times, now recoiled. The issues ran on, in an increasing volume, till they amounted to $245,000,000 in the year 1779. In 1781 the whole mass became worthless. The essays of Pelatiah Webster on this subject have become classics. Mr. Webster was a merchant of Philadelphia and an ardent patriot. He wrote while the paper-money experiment was going on. We can readily believe him when he says:

> We have suffered more from this than from every other cause of calamity; it has killed more men, perverted and corrupted the choicest interests of our country more, and done more injustice, than even the arms and artifice of our enemies.

Continental money was now an object of execration and afterwards of derision. "Not worth a continental" became a synonym for absolute worthlessness.

One of the striking phenomena of the Revolution was the great display of luxury. Franklin wrote in 1779: "The extravagant luxury of our country in the midst of its distresses is to me amazing." Another writer says: "Every form of wastefulness and extravagance prevailed in town and country, nowhere more than in Philadelphia under the very eyes of congress,—luxury of dress, luxury of equipage, luxury of the table."

This is not hard to understand. If a man owed $1,000 gold value and was enabled to pay it with $100, he had $900 disposable for other purposes. As this money had not come to hand by hard knocks, he would naturally be somewhat free in spending it. He would give good dinners, drive fast horses, and buy fine clothes and jewelry for his family. It was the transfer of property from frugal persons to spendthrifts. Like conditions prevailed during the civil war, both north and south.

At the beginning of the civil war the amount of gold in the country was unusually large. If it had been left in the banks, it would have served the same purpose during the war as before. Business transactions are no greater in amount in war than in peace, although somewhat different in kind. No more gold would have been needed, if it had been used for its proper purpose of bank clearings,—*i. e.*, as a touchstone of the paper currency. The banks ought to have made it a condition of their loan ($150,000,000 on August 9, 1861) that Mr. Chase should draw checks for his disbursements to be settled at the clearing house in the usual way. They were the masters of the situa-

tion. If they had insisted, he would have had no option but to yield. Upon this point Mr. George S. Coe, one of the most prominent men in the negotiation, says:

> The banks would have conferred an incalculable benefit upon the country, had they adhered inflexibly to their own opinions. But the pressure of startling events required prompt decision, and the well-known intelligence and patriotism of the secretary gave to his judgment overwhelming power.

Mr. Chase insisted upon carrying away the gold and scattering it through the country by means of the sub-treasuries and distributing offices. The amount so scattered was $170,000,000, and it cost a good deal to cart it around. The result was that the banks suspended specie payments on the 28th of December, 1861.

The committee of ways and means, on the 7th of January, 1862, by a majority of one vote, agreed to report a legal-tender bill proposed by Elbridge G. Spaulding of Buffalo. This action produced a great commotion in the world of finance.

A delegation of bankers from New York, Boston, and Philadelphia came to Washington to remonstrate against it. A meeting was held at the office of the secretary of the treasury on the 11th of January, at which these gentlemen and the members of the financial committees of the house and senate were present. Mr. Gallatin, in behalf of the bankers, presented a plan of national finance which would, in the opinion of those gentlemen, procure the means for carrying on the war without recourse to legal-tender notes. One of the proposals was to "issue six per cent. twenty-year bonds, to be negotiated by the secretary of the treasury, and without any limitation as to the price he may obtain for them in the market."

Mr. Spaulding took ground at once against this plan. He tells us that he "objected to any and every form of 'shinning' by government through Wall or State street to begin with; objected to the knocking down of government stocks to seventy-five or sixty cents on the dollar, —the inevitable result of throwing a new and large loan on the market, *without limitation as to price*."

In order to avoid selling government stocks at seventy-five or sixty cents on the dollar in an honest way, Mr. Spaulding initiated a policy which ended in selling those stocks at forty cents on the dollar in a roundabout way, and cheating creditors, soldiers, and laboring men out of more than half their dues in an incidental way. This state of facts he mournfully acknowledges in his book, and he seeks to put the blame on Mr. Chase for too much inflation of the currency. But the man who opens the floodgates has no right to complain of the inundation.

The bill became a law on the 25th of February, 1862. It pro-

vided for the issue of $150,000,000 of notes. On the 7th of June Mr. Chase asked for $150,000,000 more notes. A bill for this purpose was passed with very little opposition.

The third batch of legal-tender notes, $100,000,000, was authorized by a joint resolution dated January 13, 1863, "for the immediate payment of the army and navy of the United States." The whole amount now authorized was $400,000,000. The price of gold at this time was 142; at the end of the month it was 159. Mr. Spaulding was surprised, at this juncture, to find that there was a great scarcity of currency. This he attributed, not to the advance in prices, which had absorbed the additions to the circulating medium, but to the operations of the army and navy. He did not explain how the operations of a million men fighting and destroying property should call for more currency than the same number engaged in peaceful occupations at home.

An important change was made by the act of March 3, 1863, in the character of the old legal-tender notes. By the terms of their issue they were convertible into six per cent. gold-interest bonds at par, and these words were printed on the back of each note. Mr. Chase desired that this privilege should be taken away, so that he might reduce the rate of interest on future bond issues. Congress reluctantly yielded to his request, fixing a period a few months distant (July 1, 1863), when the right of conversion should cease. This was an inexcusable breach of contract, and a shocking blunder to boot, for it had the effect of preventing the early resumption of specie payments. Whenever the six per cent. bonds were above par, the notes would be converted into them and retired. This operation, being perfectly natural, being part of a contract, and coinciding with a popular feeling at the close of the war favorable to specie resumption, would have certainly worked out that result within a brief period. This feeling was expressed by a vote of 144 to 6 in the house, on the 18th of December, 1865, in favor of contraction of the currency with a view to early resumption.

Secretary McCullough in 1865 recommended that the greenbacks be gradually retired by cancelling a certain proportion of those received for taxes, and congress passed a law authorizing such retirement at the rate of $4,000,000 per month. This was done until the amount was reduced to $356,000,000, when congress repealed the law.

The money circulating among the people is a powerful educator. It teaches either truth or falsehood. Sometimes the results of its false teachings are merely whimsical; more often they are disastrous. Our legal-tender act taught people to believe lies. First, it taught them that the government's bonds were payable in greenbacks. The policy

of paying the 5-20 bonds in greenbacks was made a political issue by General Butler in the Republican camp, and by George H. Pendleton in the Democratic, immediately after the close of the war. They and many other politicians advanced the fantastic conceit that the government could pay the first piece of paper with a second one. If it could do so, then, as Professor Newcomb said, it could pay the second piece with the first. So, by a game of see-saw or thimble-rigging, the whole debt could be paid without taxation. As all the other governments could rightfully do what we could, all national debts might be settled in a twinkling. But there would be no need of taking the trouble to exchange an interest-bearing bond for a non-interest-bearing note. The whole debt could be cancelled by simply passing a law saying: "All bonds of the United States are legal tender and shall cease to bear interest after the passage of this act." If that could be called *paying* the debt, what would be repudiating it?

The reader who has penetrated thus far into the labyrinth of our currency legislation will need a clue in order to get back to daylight. It is easily supplied. The various kinds of money in circulation, exclusive of subsidiary coins, fall into two classes, namely:

Money.	Representative Money.		Amount.
Gold.	Fiat money	1 Greenbacks	$346,681,016
		2 Treasury notes	152,584,417
		3 Silver dollars	57,029,743
		4 Silver certificates	337,148,504
		Total fiat money	893,443,680
		5 National Bank Notes	206,854,787

All the things in the right-hand column are issued by the government, and are fiat money, except the national bank notes. It is customary to say that the various things composed of, or based on, silver (numbered 2, 3, and 4) are real money to some extent, because of the metallic value of the silver dollar. This is true only in case the government is at liberty to sell the silver. There is no law authorizing the secretary of the treasury to do this. Strike out from the list of representative money numbers 2, 3, and 4, and write greenbacks in place thereof, and assume that the government has certain assets of uncertain value composed of white metal, some of it stamped and some unstamped, then you know everything that can be known about the multifarious currency issued by the government of the United States. Silver dollars are metallic greenbacks. They are at par with gold because they are limited in amount and because the government receives them as the equivalent of gold at the custom house and the tax-office.

The money of the country consists of all the gold, plus all the

other instruments of exchange that are redeemable in it. It follows —and has been proved by abundant examples—that a scarcity will be cured after some delay by an importation of gold, and a plethora will be equally corrected by an exportation of it.

It is the proper business of banks to supply a deficiency and to redeem and retire an excess of the circulating medium, as the case may be. There is a general understanding of this truth, and it finds expression in the common saying that "the government ought to go out of the banking business." Banking implies the receiving of money on deposit from certain persons and the lending of it to other persons for hire. This is common to all banks, but some banks add another function,—that of issuing and redeeming circulating notes, which take the place of metallic money in the community. The former of these functions may be, and often is, exercised without the latter, but the latter ought never to be exercised without the former, because there is no means of testing the needs of the community for instruments of exchange except by holding them at the service of the bank's depositors. There is no other way for bank notes to get out of the bank, except as they are taken out by persons who have the right to draw checks on it. These are the depositors. Each depositor knows exactly how many bank notes he needs. He will draw out no more or no less, and, when he has on hand any more than he needs, he will deposit the excess in the bank. As all depositors do the same, the needs of business are answered automatically. As the government has no such machinery, it has no means of squaring the volume of the currency to the needs of business. It has no means of knowing what the needs of business are, and, if it had any, it would still be without means of responding to them, except by taking a vote in congress. After taking the vote, it would still be without any method of placing the money where it was really needed.

The redemption of fiat money is always liable to contingencies. The government may not be *able* at all times to redeem it. The government may not be *willing* at all times to redeem it, in which case it cannot be coerced, or fined, as a bank may be for similar default. The national honor is a very poor substitute for the sheriff and his posse, to keep specie payments going, because so many people have to be consulted, and because different views prevail as to what the national honor requires. We have had some recent illustrations of this divergence of ideas between different branches of the government on such a delicate question. Such differences tend to create panics and cause runs on the treasury.

There is a vast amount of floating capital in the modern world which seeks investment on call, or short time. It may be at New

York to-day, at London a month hence, at Paris, Berlin, Vienna, Amsterdam, or other places, at short intervals, or divided among all of them. It is capable of being transmuted into gold and sent hither and thither at short notice. A very slight inducement will cause it to be turned this way or that way. It is always on the alert to make a profit or to avoid a loss, especially the latter. It was this sort of capital that was taking wings and leaving our shores, accompanied by a considerable amount of American capital in the same liquid state, last winter.

The greatest objection of all to fiat money is that it teaches people to believe lies. It creates the belief that the government can make money,—that is, real, not representative, money,—than which a more damaging lie never gained lodgment in the human brain. It has kept political parties in hot water for thirty years. It is an obstacle to the nation's progress, and ought to be put out of its misery without further delay.

The striking concurrence of opinion between Mr. White, writing as an economist and thinker, and President Cleveland, writing as the chief executive of the American people, charged with putting theory into practice, is shown by the following recommendations contained in the president's message to congress last month:

I am convinced the only thorough and practicable remedy for our troubles is found in the retirement and cancellation of our United States notes, commonly called greenbacks, and the outstanding treasury notes issued by the government in payment of silver purchases under the act of 1890.

The currency withdrawn by the retirement of the United States notes and treasury notes, amounting to probably less than $486,000,000, might be supplied by such gold as would be used on their retirement or by an increase in the circulation of our national banks. Though the aggregate capital of those now in existence amounts to more than $664,000,000, their outstanding circulation based on bond security amounts to only about $190,000,000. They are authorized to issue notes amounting to 90 per cent. of the bonds deposited to secure their circulation, but in no event beyond the amount of their capital stock, and they are obliged to pay 1 per cent. tax on the circulation they issue.

I think they should be allowed to issue circulation equal to the par value of the bonds they deposit to secure it, and that the tax on their circulation should be reduced to one-fourth of 1 per cent., which would undoubtedly meet all the expenses the government incurs on their account. In addition, they should be allowed to substitute or deposit, in lieu of the bonds now required as security for their circulation, those which would be issued for the purpose of retiring the United States notes and treasury notes.

The banks already existing, if they desired to avail themselves of the provisions of law thus modified, could issue circulation in addition to that already outstanding, amounting to $478,000,000, which would nearly or quite equal the currency proposed to be canceled. At any rate, I should confidently expect to see the existing national banks or others to be organized avail themselves of the proposed encouragements to issue circulation, and promptly fill any vacuum and supply every currency need.

CRIPPLE CREEK GOLD MINES AND THE STOCK BOOM.

By T. A. Rickard.

THE vicissitudes of mining are proverbial. The fascinating romance of western development offers many a page telling of the ups and downs of settlements whose oddly-chosen names are now a part of the record of American enterprise. Cripple Creek, the mining camp whose recent achievements have made it a subject of interest to the commercial world, has had a career as chequered and brilliant as any of those whose names have been words to conjure with in the mining excitements of the past. The Comstock, Tombstone, Leadville, the Cœur d'Alene, Wood River, the Black Hills,—what pictures of potentialities of wealth beyond the dreams of avarice do they not recall! Picturesque discovery, rapid development, extraordinary productiveness, insane speculation, honest endeavor, ill-gotten gain, exhaustion, collapse, succeeded after an interval of convalescence by another cycle of similar events. It is an old story, whose brighter aspects are treasured as a part of the heritage of the children of the departing pioneer, the unpleasant features of which are buried in that forgetfulness which is happily characteristic of an optimistic humanity.

The wave of emigration which, after the financial panic of 1857, swept westward until it broke against the ramparts of the Rocky mountains was the vanguard of a new civilization. To those who were carried forward by its impetus there ever loomed above the sea of the prairies the beacon whose white crest on far horizon gave promise of the land of gold. That beckoning guide was the snowclad peak which Capt. Zebulon Pike had reconnoitred forty years before. The "Pike's peak or bust" motto of the pioneer sounds but mock heroic in our ears, and yet it expressed something of the mingled humor and daring which were no small part of the equipment of the men who first pierced the unknown wilderness of what was then the western portion of the territory of Kansas.

Although the peak thus lent its name to the mining excitement of that time, no gold discoveries of any moment were made in the streams or on the hills that lay at its feet. The rugged ranges which look up at Mt. Arapahoe, Gray's peak, and Mt. Evans were the scene of the beginnings of Colorado mining. Time has of late reversed his wheel and justified the expectations of the tenderfoot of forty years ago by the uncovering, upon the southern slopes of the old beacon moun-

tain, of a gold-mining region of a richness and extent far exceeding those of any of the districts first opened up by Gregory or the Russells in the days before 1860.

Cripple Creek, the latest born and the goodliest of Colorado's galaxy of mining camps, lies under the very shadow of Pike's peak. Though the first recorded locations bear date of February, 1891, the district was previously well known on account of having been the scene, seven years earlier, of the notorious Mt. Pisgah fiasco.

Among the clustering hills which, like a flock of sheep, spread southward from the granite battlements of Pike's peak there is a dark cone somewhat detached from its smaller brethren. It is Mt. Pisgah. And just as Moses from the top of the Asiatic Pisgah looked over a land flowing with milk and honey, so the modern prospector, saturated with an ill-assorted medley of fact and fancy, ascends this Colorado hill, and from its summit sees a country which, to him, at some vaguely remote period, flowed with porphyry and gold. But Mt. Pisgah has an unsavory reputation. In April, 1884, three or four thousand men stampeded thither on the rumor of a great discovery. No gold was found in workable quantity, except in the prospect holes of the first locators. Salting was suspected, and an accomplice was caught with a bottle of yellow stuff in his pocket. It was not whisky, but its latter-day antidote, chlorid of gold. Lynching was threatened, but in the failure to lay hands on the real perpetrators of the fraud the affair broke up in a big picnic and a general drunk. What digging had been accomplished was unsuccessful, though one or two veins were found that carried from $3 to $4 in gold per ton. It makes one cynical to think how near those excited and deluded prospectors were to the eve of a big discovery. No mines have to this day been found on the slopes of Mt. Pisgah, but the town of Cripple Creek is within a rifle shot, and on the opposite grassclad slopes there are scores of engines throbbing loudly as they hoist the produce of several series of successful mines. And one can almost fancy that Mt. Pisgah's dark front grows gloomier as it contemplates the "might have been."

It is not known to many that even earlier than the episode just chronicled there was silver mining at Cripple Creek. In the days before the labor troubles in the late unpleasantness of 1893 such a fact would have been more attractive than it is to-day when the white metal is discredited and we are all possessed with the *sacra fames auri*. However, as far back as 1874 there was a hole sunk on what is now the well-known Elkton vein, and out of it there came ore which carried 30 ounces of silver per ton. In the neighboring mine, the Moose, also locally celebrated for its productiveness, I have seen specimens of horn silver (cerargyrite or chlorid of silver). The same specimens showed

native gold. A recent shipment of 30 tons gave a return of 74 ounces silver and 50 ounces gold per ton.

Nevertheless, it was not until the close of 1893 that Cripple Creek came to the front. Two years before that the name had begun to be mentioned in mining circles, but the contemporaneous discoveries of large silver lodes at Creede diverted attention for the time. The collapse of the silver market in June, 1893, prostrated Creede, in company with all the other silver-producing camps, and caused the concentration of the energies of the State upon its gold resources. At this period the men of Aspen and Leadville flocked into a camp which theretofore had been left to the less experienced hands of the pleasure-loving community of Colorado Springs. Cripple Creek's development progressed apace, and resulted in the immediate opening up of several rich mines and the commencement of a steadily growing gold production.

Cripple Creek is the *fin de siècle* mining camp. Before it was two years old, it had two railroads uniting it with the highways of commerce. When scarce emerged from the tent stage of its growth, it was illuminated by electricity. To day it possesses several stock exchanges, and it has already passed through the measles of a real estate boom.

Some one has said that, like Rome, Cripple Creek has its seven hills. It is indeed true that the productive part of the district covers about twenty square miles spread over a group of low hills whose grass-clad slopes, occasionally darkened by a cluster of pines, remind one of the fact that only a short time ago this was a region valued as a cattle range. The smooth contours have since been broken by innumerable prospect holes, whose waste dumps of yellow rock seen at a distance suggest the irruption of the surface by an army of gophers. On nearer approach the variety of the rocks exposed in these surface workings becomes evident even to an untechnical observer, and, on referring to the recently-published report of the United States geological survey, one recognizes immediately that the petrography of the region is so complex and varied as to give the colored map the appearance of a crazy quilt.

Of the geology of the district much might be said, did space permit. When first investigated by the men who came from the older settlements of Colorado it proved so puzzling as to give the impression that it was unlike any other mining region in the State. Experience with the fissure veins of Clear Creek and Gilpin counties or with the limestone deposits of Aspen and Leadville seemed at a discount, and caused many absurd misconceptions regarding the vein structure of the new district. Then there somehow arose the impression that professional geologists and properly-trained mining engineers did in its early stages

condemn the camp on account of its unfamiliar formation. This is distinctly untrue. It was the so-called "practical miner"* who from the pages of a local experience generalized concerning a district having appearances unfamiliar to his restricted vision. The fact is that the structural geology of Cripple Creek is such that it at once impresses the trained observer as possessing all the environment required for the deposition of valuable ores. It is not the least pleasing of the recollections of the writer that in 1893, standing inside certain surface excavations on Battle mountain, he stated the conviction that he was looking at the beginnings of a big mine. Those surface workings have since then developed into the celebrated Independence mine, easily the most interesting scientifically and most valuable commercially of the gold producers of the camp.

No district within modern observation so well illustrates the more recent views on ore deposition to which much attention has been directed by the writings of the late Prof. Posepny and others of his school. The region is a complex of volcanic rocks, penetrating and, in part, covering, the basal granite. The ore occurs largely in the form of a later enrichment of dikes which traverse the older eruptives. A striking structural feature, of great practical importance in the exploration of the mines, is that sheeting of the rock by reason of which it becomes divided by numerous parallel fracture planes, some of which are accompanied by ore. The deposition of valuable mineral aggregates on one or more of such lines of fracture and the passage of the ore-streak from one to the other cause complications which will enable the young science of geology to guide its older blind brother, the industry of mining.

In parenthesis I would call attention to a very striking geological parallel existing between Cripple Creek and the Thames district in New Zealand. It may be well also to remind Colorado men that the masses of andesite breccia characteristic of their new gold field also occur in far more enormous bodies in the San Juan region, and that this formation is there marked by inclosing veins having a mineralization by no means dissimilar in many respects to that noted at Cripple Creek.

Boulder county (Colorado) and Transylvania, the ancient Dacia, in Europe, offer further examples of an association of tellurid minerals to be compared with similar mineralogical occurrences in this district.

The ores of Cripple Creek are of considerable variety and remarkable beauty. Crystalline native gold is common in all the rich discoveries. It is associated with those compounds of gold, silver, and

* As if a miner could be other than practical. The unnecessary emphasis on the latter word is usually by way of apology for general ignorance.

tellurium which are technically termed tellurids. The characteristic mineral is called calaverite by the gentlemen of the United States geological survey, although Dr. Pearce and others familiar with the ores consider that the analyses indicate that it is sylvanite.* It is a silver-white mineral, often in elongated crystals and associated with dull red splashes of native gold, whose graphic habit indicates that it was derived from the decomposition of the tellurid. The most striking mineral association of the region is that of native gold and purple fluorspar. The coloring imparted by the presence of the latter produces contrasting tints of remarkable beauty.

To the metallurgist who is called upon to extract the values in these ores the most evident feature of the material shipped to him for treatment is its identity with country rock. That the ores of veins are frequently composed of rock in place impregnated by mineralizing waters is a theory susceptible of proof in many localities. At Cripple Creek it is an immediately obvious fact. The managers of the Denver smelters will tell you of their astonishment in receiving, in the early days of the camp's history, carloads of material which to them seemed to be rock excavated from a railroad cutting, which by mistake must have been switched into the place of ore-cars. Much of the ore is phonolite, andesite breccia and granite, so little changed that it needs no second glance to recognize the rock type, while it does require careful scrutiny to distinguish the evidences of mineralization.

Of the persistence of the ore in depth there is already excellent evidence; but in this matter, as in other impressions concerning the gold field, it is very necessary to emphasize the statement that, owing to the variation in the rock structure, there is a notable diversity in the character of the veins uncovered in different parts of the region. Generalizations are proverbially dangerous; they become particularly so in reference to the behavior of ore deposits distributed amid radically different geological environments. Thus I am persuaded that the ore discoveries in certain parts of the Cripple Creek area are doomed to be of a comparatively restricted nature. The experience of some of the mines already corroborates this view. On the other hand, certain systems of vein fissuring, notably on Battle mountain, bear the impress of being destined to remarkable continuity and persistent productiveness. No vein within my knowledge has shown itself so unaffected in richness by a change in the country rock or so superior to the impoverishing changes which usually accompany increasing depth as the Independence, which penetrates from porphyry (an andesite breccia) into granite without any evident dim-

* Calaverite carries tellurium 55.5, gold 44.5, with variable, but very small, percentage of silver. Sylvanite carries tellurium 55.8, gold 28.5, silver 15.7 per cent.

inution in values and cuts right across the contact between the two formations with no disturbance in its continuity save a local widening of the ore body. The ideal "true fissure vein" of the geologists of the old school of Henwood and Von Cotta is here amply fulfilled.

The ores of Cripple Creek are distinctly high-grade. The chief Australian mining centers* produce millstuff whose average contents are 9 dwts. per ton, the typical mines of California† do very well with quartz even poorer than that, the older districts‡ of Colorado are happy with 6 to 8 dwts. per ton, and the mines of the Rand, which made South Africa the leading gold-producing country of the world, are doing great things with conglomerates averaging 11 dwts. per ton. Cripple Creek's output carries an average of nearly 3 ounces of gold per ton. The 40,000 tons received during the past year by one smelter alone averaged $78 per ton, or over 3½ ounces. The first-class ore of many of the mines carries more than 10 ounces of gold per ton. It is not remarkable, therefore, that a comparatively small tonnage should run up into big figures. The yield for 1895 is sure to reach eight million dollars. At the close of the year the monthly production is quite double that of the beginning, and there is promise of a continued increase.

Thus, therefore, there is ample scientific evidence and commercial proof of the value and resourcefulness of the new gold field, fully warranting the inauguration of mining enterprises of great moment.

Side by side with healthy development and honest effort there has sprung up a mushroom growth of stock exchanges whose function it is to offer a vent to that hungering for sudden wealth which is the curse of our day. Just now the newspapers give more space to the transactions in stocks than they do to the actual operations at the mines, and the multiplication of exchanges has progressed so far that the camp itself has three, Colorado Springs has organized four, while Pueblo and Denver are hastily following suit. Every day sees the registration at the office of the secretary of State of a dozen or more mining companies having a nominal capital of a million dollars or more and an unproved mining claim for its sphere of operation. The subdivision of liability by the creation of a great number of low-priced shares has proceeded so far that $50 can buy several thousand shares. These low prices are used as a bait to catch small fish. Persons unable to take an interest in a properly-equipped mining enterprise are seduced into a traffic which enables them by the payment of their small savings, to profit by the rise, sure, so it is said, to follow the boom. The philosophy of such transactions is usually simple. A speculator may be foolish to buy

*Bendigo and Ballarat.

†In Calaveras, Amador, and Nevada counties.

‡Clear Creek and Gilpin counties.

a thousand shares in the Great Wild Cat Extended Mining and Milling Company for the sum of $10 or $20, but there is the glorious probability, verging on a certainty, that another more foolish speculator will appear, upon whom these shares can be subsequently unloaded at a nice profit. This little human frailty is the basis for the widespread promotion of numberless companies and the issue of a flood of prettily-engraved stock certificates.

This result is fed on statements of the greatest inaccuracy published in the press and voiced by men who have been hitherto considered well informed. The owner of a well-known mine has stated that any patented, though undeveloped, claim within the Cripple Creek mineral area is worth $25,000; and such a statement is at once utilized by those promoters whose business it is to sell that which they do not possess to those who do not want it. A conservative and distinguished smelter manager pronounces the opinion that only the high-grade ores are at present being treated, that there is an unlimited supply of low-grade ores in the mines of the district, and that the multiplication of reduction plants will render this supply available and enormously augment the returns. This is a delusion. The veins of Cripple Creek are characteristically small, and equally as characteristically carry ore of very high grade; the amount of low-grade ores remaining in the mines is strictly limited, and neither requires any very extensive addition to the leaching establishments now in operation,* or warrants the instituting of parallels with the output of South Africa. The output for 1895 will be about 150,000 tons, averaging about 3 ounces per ton. The *monthly* production of the Rand is over 300,000 tons containing about ⅔ ounce of bullion, or a trifle over ½ ounce of pure gold, per ton. Comparisons of a misleading kind are, nevertheless, daily made by writers in the daily press who have no proper knowledge of the Cripple Creek mines and possess scarce a bowing acquaintance with the first facts pertaining to the industry of the Witwatersrand.

The immediate fruit of all this is a rapid growth in stock speculation which is calculated to injure rather than aid legitimate mining. Cannot we profit by the experience of the past, and take to heart the old saying, *qui va piano, va sano?* The worst of all waste is the waste of experience. Let those who desire to invest in mines (and no form of investment is more alluring or, under proper restrictions, more profitable) base their expectations on what is in the mine rather than on the uncertain vagaries of a speculative epidemic; let them work ore and

* The writer does not lose sight of the fact that just now the output is ahead of the reduction plants, but it will not require any remarkable additions to the plants to overcome this.

not the public, and, eschewing two-cent shares in million-dollar companies organized on the slim foundation of a ten-foot hole, wait their opportunity to invest in mines properly developed and thoroughly examined by competent and reputable engineers. It is a truism, so stale as to be cynical, to say that the world's oldest industry requires the use of methods common to our every-day business. Mining, to be successful, requires the aid of the best modern skill. The chances for disappointment are sufficient without creating new ones by a willful disregard of the necessary care and playing the fool, as many do, with the expectation that miracles will happen.

Just as the phenomena of ore occurrence in the Cripple Creek region invite for their decipherment the aid of geological observation, so also the exploitation of the mines and the treatment of the ores require the assistance of the kindred sciences. It is too late in the day, it is too much of a puerile disregard of the experience of our elders, for us to embark in large mining enterprises without an equipment of business judgment, technical skill, care, and economy.

In considering the rapid development of our new gold field attention is attracted to a wider phenomenon. The collapse of silver, two years ago, has proved in many ways a blessing in disguise. It checked that discounting of the future which is at once the charm and the bane of our western life; it put a stop to a mania for reckless extravagance, and ushered in an era of sound economy; it awakened the resourcefulness and demonstrated the latent pluck of the citizens of Colorado; and it has resulted in throwing fresh life into the development of our gold resources, as is now evidenced by the opening up of new centers of production, not only at Cripple Creek, but also in the Leadville district, in the San Juan, in old Gilpin, and in other regions whose records are a part of the story of American achievement.

THE FUTURE OF THE AMERICAN IRON TRADE.

By James M. Swank.

THE editor of THE ENGINEERING MAGAZINE asks me to send him for publication my views upon the above far-reaching subject. To do this in a way that will afford instruction to his readers I must be both prophet and statistician. In the latter capacity I feel sure of my ground, but in the former I am admonished that it is possible to go very far astray. There is, however, one rule to be observed in peering into the future which commends itself to all prophets, and which, in its application to our iron and steel industries, may be said to blend prophecy with statistics. It is contained in Patrick Henry's declaration, "I know of no way of judging the future but by the past."

First, then, we will look at the past of these great American industries. This past covers a longer period of time than is generally supposed. Beginning with an abortive attempt at ironmaking on Falling Creek, Virginia, in 1622, and with a successful attempt at Lynn, Massachusetts, in 1645, the manufacture of iron was fully established before the Revolution in all the original thirteen colonies, except Georgia. Historic names are associated with our colonial iron industry. Mordecai Lincoln, of Scituate, Massachusetts, from whom Abraham Lincoln was directly descended, was the principal owner as early as 1703, in company with his brother, Daniel Lincoln, of the Bound Brook Iron Works, not far from Hingham. Augustine Washington, the father of George Washington, was engaged in the manufacture of pig iron at Accokeek Furnace, in Stafford county, Virginia, at the time George Washington was born, in 1732, and he retained his connection with this furnace and with other iron enterprises of the Principio Company, of Maryland, until his death in 1743. His iron interests were continued in the Washington family down to the Revolution. Several signers of the Declaration were colonial iron manufacturers, as were also two of the most notable officers of the Continental army, General Nathaniel Greene and Colonel Ethan Allen. In 1742 Benjamin Franklin invented the Franklin stove, which is still in use in some old Pennsylvania houses. Pig iron and bar iron were exported from the colonies to England in the first half of the eighteenth century, and shipments of these articles to the mother country attained considerable proportions in subsequent years down to the breaking out of hostilities.

After the Revolution our iron and steel industries were further developed, but slowly and spasmodically for many years, owing to the severity of foreign competition, which was only occasionally checked by tariff legislation. With the enactment of the Morrill protective tariff on March 2, 1861, and with the added stimulus of the civil war, our iron and steel industries at once entered upon a period of extraordinary development, which, with some interruptions, has continued to the present time, greatly surpassing the development of like industries in any other country.

Our blast-furnace practice has been completely revolutionized since 1860 by the introduction of more powerful blowing engines and improved hot-blast stoves, by the increased height and width of the furnaces, and by the general use of bituminous coke and of richer and purer iron ores, the latter coming chiefly from the Lake Superior region. In 1865 not more than 100,000 tons of coke were consumed in the production of pig iron in this country, but now many times as much pig iron is produced with coke as with all other fuels combined, the consumption of coke in our blast furnaces amounting this year to more than 7,000,000 tons. In 1860 only 114,401 tons of iron ore were shipped from the Lake Superior mines, but in 1890 there were shipped 9,012,379 tons, and in 1895 the shipments promise to amount to 10,000,000 tons. As a result of all these changes, we have recently made in one year more than ten times as much pig iron as we made in any year immediately prior to 1861, and with a smaller number of furnaces in active operation. In 1860 we made 821,223 tons of pig iron, and in 1890 we made 9,202,703 tons.

The total production of steel in the United States in the census year 1860 was reported to have been 11,838 tons, part of which was blister steel and the remainder crucible steel, both products of very old manufacturing processes. We had just commenced the manufacture of crucible steel. In 1864 the manufacture of bessemer steel in this country was successfully undertaken, and in 1868 we made our first open-hearth steel. In 1892 our production of all kinds of steel, chiefly bessemer and open-hearth steel, was 4,927,581 tons.

In the rolling and forging and founding of iron and steel, in the manufacture of heavy as well as light machinery of iron and steel, and in the adoption of labor-saving appliances in the mining and shipment of iron ore and for the handling as well as the production of iron and steel, this country has always kept pace with the world's progress, and in many particulars it has shown the superiority of its methods over those of all other countries.

It is only just to say that the marvelous progress of our iron and steel industries since 1860 could not have been possible if we had not

in the meantime opened one after another the rich iron-ore mines of the Lake Superior region, and gradually, year after year, substituted Connellsville coke for other fuel in the blast furnace. Other ores, notably the cheap ores of some of the southern States, and other coke, notably that of the Pocahontas Flat Top region, have in recent years contributed largely to our production of iron and steel, but it is nevertheless true that without Lake Superior ores and Connellsville coke we would still be in vassalage to Europe for many iron and steel products.

It was not until 1867 that we began to substitute bessemer-steel rails of domestic manufacture for iron rails, although small lots of bessemer-steel rails were imported in 1864, 1865, and 1866. In 1872 we made 808,866 tons of iron rails, which was the largest yearly product ever attained, and only 83,991 tons of bessemer-steel rails. We continued to make more iron rails than steel rails until 1877, but in that year iron rails fell behind steel rails, and ten years later, in 1887, we made 2,119,049 tons of steel rails, practically all of which were bessemer rails, and only 20,591 tons of iron rails. In 1894 we made 4,674 tons of iron rails. Our iron-rail industry, which attained its maximum growth in 1872, is now virtually extinct. So completely have steel rails taken the place of iron rails in this country that in 1894, according to *Poor's Manual*, 84.8 per cent. of the total railroad track of the United States had been laid with steel rails. This change has chiefly taken place within the last fifteen years. In 1880, according to the me authority, iron rails still formed 70.9 per cent. as of our total railroad track.

Ten years ago the making of heavy armor plates was an untried industry in this country, but to-day our heavy armor plates are admitted to be the best in the world, and within the last year the Russian government has purchased American armor plates in preference to those made in European establishments. The rapid strides which this country has made in the last few years in the building of steel merchant vessels for ocean and lake service and in the building and armament of a new navy are the world's wonder, and reflect the highest credit upon our steel manufacturers as well as upon our shipbuilders. The great progress that has been made in late years in this country in the construction of steel bridges and in the substitution of iron and steel for wood in the erection of public and private buildings, particularly the very high buildings that are now to be seen in all our large cities, could not have taken place, if our iron and steel manufacturers had not first demonstrated their ability to produce the structural forms required and at low prices. It is within the bounds of probability that the production of structural steel in this country in

1895, embracing beams, beam girders, zee bars, tees, channels, angles, and plate girders, will amount to 1,000,000 tons. Excluding plate girders our production of structural steel in 1894—a year of depression—amounted to 505,901 tons.

It was not until near the end of the first quarter of the present century that we made any considerable quantity of nails with the cut-nail machines with which the present generation is familiar. Until 1883 all our cut nails were made of iron, but in that year we began to make them of bessemer steel, and in the same year steel-wire nails began to come into use as a substitute for cut nails. In 1894 nearly all our cut nails were made of steel, but the quantity of cut nails produced had fallen far below that of wire nails, the production for that year being as follows: cut nails, 2,425,060 kegs; wire nails, 5,681,801 kegs.

It may be doubted whether many persons realize the magnitude of the steel-wire industry of this country. The 5,681,801 kegs of wire nails manufactured in 1894 were the equivalent of 253,652 tons. Almost as many tons of steel wire for fencing are also annually produced. The manufacture of wire rope is another leading branch of our steel-wire industry, and so also has been the manufacture of telegraph and telephone wire. Electric railways, too, require large quantities of steel wire. As has been shown, we did not make the steel for these articles until after 1860. The wire cables for the Brooklyn bridge, which was completed in 1883, were made of American steel.

Closely related to our steel-wire industry is our wire-rod industry. Twenty years ago we made very few steel-wire rods. The duty on rods was increased in 1883. In 1888 we made 279,769 tons of iron- and steel wire-rods, and in 1894 we made 673,402 tons, virtually all of which in both years were made of steel.

Our tinplate industry, the youngest of the industries belonging to the American iron trade, is wholly the creation of the last five years. Its marvelous growth is shown in the following summary from official statistics of our production of tinplates and terne plates during the four fiscal years beginning with July 1, 1891, and ending with June 30, 1895: fiscal year 1892, 6,092 tons; fiscal year 1893, 44,562 tons; fiscal year 1894, 62,153 tons; fiscal year 1895, 86,518 tons. This progress was made during a period which embraced two years of severe financial depression, followed by a sharp reduction in the tinplate duty. While we have been so rapidly developing our tinplate industry, we have developed with equal rapidity the manufacture of black plates, or sheets, to be tin-coated or terne-coated.

Natural gas has played an important part in the manufacture of finished forms of iron and steel since 1874, when it was first used in this country in puddling and heating furnaces and in the generation

of steam. In 1886 every rolling mill and steel works in Allegheny county, Pennsylvania,—55 in all,—used natural gas as fuel, and in the same year it was used in 13 other mills and steel works; in most of them it was used exclusively. In 1887 there were 96 mills and steel works which used natural gas as fuel, either wholly or in part, and in 1889 there were 104; but at the beginning of 1894, owing to the exhaustion of many sources of supply, there were only 79. The number has since declined. It is worthy of note, however, that the development of our iron and steel industries has been greatly promoted by the use of this model fuel, and that our tinplate industry especially owes much of its original and present activity to the use of natural gas in Indiana and some other States.

The rapid development of our iron and steel industries since 1860 could not, of course, have been possible without the aid of skilled metallurgists and engineers, who have in turn been largely indebted to our scientific and technical schools; yet it is remarkable that it was not until after the opening of the thirty-five-year period under consideration that the chemical analysis of iron ores, blast-furnace fuel, and pig iron received general attention. As late as 1866 few furnacemen ever thought of having iron ores, fuel, limestone, slag, or pig iron analyzed. Now practically all iron ores and pig iron in this country are sold by analysis, or upon reputation established by analysis, and chemical as well as physical tests are required in all sales of finished iron and steel which are subjected to extraordinary strain or pressure.

One result of the improvements that have taken place in the manufacture of iron and steel in this country in the last thirty-five years has been the partial or complete abandonment of time-honored methods of production which could not compete with the new methods. In 1860 only iron was used in the production of bars, rods, plates, sheets, and rails, and the puddling furnace was an indispensable agency in their production. To-day the puddling furnace is second in importance to the bessemer converter and the open-hearth furnace, which will encroach upon it more and more from year to year. The Danks puddler, from which so much was expected twenty years ago, is never mentioned. The cementation furnace for making steel and the slitting mill for making nail rods survive only as curiosities. The blast furnaces that were run by water have nearly all gone. Except for special purposes, the day of small furnaces is over. Forges for making bar iron from pig iron disappeared about 1860, but forges for making blooms, billets, and bars direct from the ore and blooms from scrap iron and pig iron have made a more vigorous struggle for existence; yet nearly all of these have also disappeared. As late as 1850

there were more pig- and scrap-iron forges in Pennsylvania than rolling mills, and as late as 1876 there were more iron-ore forges in New York than rolling mills. For many years after 1860 there were more iron-ore forges than rolling mills in several southern States.

The low prices at which steel rails of home manufacture have been sold to our railroad companies will serve as an illustration of the cheapening of all iron and steel products in this country. The average price of bessemer-steel rails at American mills in 1870 was $106.75 a ton, in currency. The duty of $28 a ton was imposed in that year, and the price of steel rails fell in five years to an average of $68.75 a ton, and it has never since risen above these figures, but has steadily fallen in most of the succeeding years. In the whole of the year 1894 the price was $24 a ton, and in the early part of 1895 it was $22 a ton, or less than a cent a pound. It is now $28 a ton, which is exactly the amount of the duty that was imposed in 1870.

During the whole of the thirty-five years under review the extension of our railroad system has been the leading commercial factor in building up our iron and steel industries. Our railroads have called for large quantities of iron and steel for rails, bridges, cars, locomotives, and other purposes. At the close of 1860 there were in this country 30,626 miles of steam railroad completed and in operation, and at the end of 1894 there were 179,279 miles, these being Mr. Poor's figures. With the exception of 64.74 miles of elevated railroad in New York and Brooklyn, the mileage of elevated and street railways is not included in the above figures for 1894. *The Street Railway Journal* for July last gives the aggregate track mileage of these railways, including elevated roads, as 13,588 miles.

I have entered sufficiently into details to show the marvelous progress of our iron and steel industries since 1860, and also to illustrate the substitution of new for old methods of manufacture and of steel for iron. I will now present a table which will show the yearly growth of some leading branches of our iron and steel industries from 1860 to 1894, and also the yearly production of pig iron by Great Britain during the same period of thirty-five years.

The statistics of pig-iron production by Great Britain are given to show how much more rapid has been the progress of our pig-iron industry since 1860 than that of our rival. Great Britain produced almost as much pig iron in 1860 (3,826,752 tons) as the United States produced in 1880 (3,835,191 tons); and yet, notwithstanding the fact that we started so far behind in the race, we made in 1890 more pig iron than Great Britain had made in any previous year or has since made. Her maximum production (8,586,680 tons) was attained in 1882; ours (9,202,703 tons) in 1890.

Our production of bessemer-steel rails exceeded that of Great Britain in 1879, and we have ever since retained the leadership in this branch of the steel industry. Beginning with 1884, we have continuously led our great rival in the production of bessemer-steel ingots, and since 1890 we have been uniformly in advance of Great Britain in the aggregate production of all kinds of steel.

Years.	Total Shipments of Lake Superior Iron Ore. Gross tons.	Production of Pig Iron in the United States. Gross tons.	Production of all kinds of Steel in the United States. Gross tons.	Production of Iron and Steel Rails in the United States. Gross tons.	Production of Pig Iron in Great Britain. Gross tons.
1860.....	114,401	821,223	11,838	183,070	3,826,752
1861.....	49,909	653,164	.....	169,480	3,712,390
1862.....	124,169	703,270	.....	190,993	3,943,469
1863.....	203,055	846,075	8,075	246,221	4,510,040
1864.....	243,127	1,014,282	9,258	299,437	4,767,951
1865.....	236,208	831,770	13,627	318,118	4,825,254
1866.....	278,796	1,205,663	16,940	384,623	4,523,897
1867.....	473,567	1,305,023	19,643	412,596	4,761,023
1868.....	491,449	1,431,250	26,786	452,423	4,970,206
1869.....	617,444	1,711,287	31,250	529,988	5,445,757
1870.....	830,940	1,665,179	68,750	553,571	5,963,515
1871.....	779,607	1,706,793	73,214	692,619	6,627,179
1872.....	900,901	2,548,713	142,954	892,857	6,741,929
1873.....	1,162,458	2,560,963	198,796	794,712	6,566,451
1874.....	910,557	2,401,262	215,727	651,262	5,991,408
1875.....	891,257	2,023,733	389,799	707,600	6,365,462
1876.....	992,764	1,868,961	533,191	785,383	6,555,997
1877.....	1,015,087	2,066,594	569,618	682,776	6,608,664
1878.....	1,111,110	2,301,215	731,977	788,112	6,381,051
1879.....	1,375,691	2,741,853	935,273	993,993	5,995,337
1880.....	1,908,745	3,835,191	1,247,335	1,305,212	7,749,233
1881.....	2,306,505	4,144,254	1,588,314	1,646,518	8,144,449
1882.....	2,965,412	4,623,323	1,736,692	1,507,851	8,586,680
1883.....	2,353,288	4,595,510	1,673,535	1,214,905	8,529,300
1884.....	2,518,692	4,097,808	1,550,879	1,022,188	7,811,727
1885.....	2,466,372	4,044,526	1,711,920	976,978	7,415,469
1886.....	3,568,022	5,683,329	2,562,503	1,600,537	7,009,754
1887.....	4,730,577	6,417,148	3,339,071	2,139,040	7,559,518
1888.....	5,063,693	6,489,738	2,899,440	1,403,700	7,998,969
1889.....	7,292,754	7,603,642	3,385,732	1,522,204	8,322,824
1890.....	9,012,379	9,202,703	4,277,071	1,885,307	7,904.214
1891.....	7,062,233	8,279,870	3,904,240	1,307,176	7,406,064
1892.....	9,069,556	9,157,000	4,927,581	1,551,844	6,709,255
1893.....	6,060,492	7,124,502	4,019,995	1,136,458	6,976,990
1894.....	7,748,932	6,657,388	4,412,032	1,021,772	7,427,342

In my annual report for 1892 I presented a table which gave the production of pig iron and steel in all countries in 1890, or in the latest years for which complete statistics were available. This table showed that this country's percentage of the world's production of these essentials of modern civilization was then as follows: pig iron, 33.9 per cent.; steel, 34.7 per cent. It is reasonably certain that our

proportion of the world's production of both pig iron and steel in 1895 will be as large as in 1890, notwithstanding the progress that Germany and some other countries have made in the meantime in developing their own iron and steel industries. Our production of pig iron in 1895 will exceed 9,000,000 tons, and our production of steel will considerably exceed 5,000,000 tons.

The magnitude of our iron and steel industries may also be seen in the statistics for the census year 1890. The whole number of establishments engaged in the production of pig iron, the production of crude steel, the rolling of iron and steel, and the production of iron blooms and billets in the United States in the census year 1890 was 719; the capital invested was $414,044,844; the number of employees was 175,506; the amount of wages paid was $95,736,192; the miscellaneous expenses amounted to $18,214,948; the cost of materials used was $327,272,845; and the value of all products was $478,687,519. If a census of our iron and steel industries were taken to-day, it would be found that the foregoing figures would be greatly increased. The statistics given do not include the operation of our iron-ore mines, which are an essential part of our iron and steel industries, and which in the calendar year 1889 employed $109,766,199 of capital and 38,227 employees. Nor do they include the capital invested and wages paid in the production of coal and the manufacture of coke for use at our iron and steel works.

The iron and steel industries of this country, as well as all other productive industries, were greatly depressed during 1893 and 1894, owing to causes which need not here be explained. In the closing months of 1894 the demand for iron and steel increased, but prices did not advance, nor was there any notable advance in prices until after the close of the first quarter of 1895. Soon after the beginning of the second quarter an increased demand for iron and steel and a rapid advance in prices occurred. During the period from May to October the iron trade of this country experienced all the conditions of a genuine boom. The demand for all products except steel rails was active and persistent, the demand for structural steel being abnormally great. Even the demand for steel rails increased. Prices of pig iron and of some of the heavier forms of finished iron and steel advanced during this period 40, 50, and 60 per cent. About the middle of September the extraordinary demand began to slacken and most prices began to weaken, the reaction, which was of moderate proportions and wholly devoid of excitement, continuing through October. In September and October the furnaces and rolling mills and steel works were, however, as busy as they could be in filling old and new orders. In November and December the slackening in demand has been more pronounced, and

prices have been weaker, although still far above those which prevailed in the first quarter of the year. While the iron trade is still in a condition of healthy activity, with fairly remunerative prices, the boom of last summer is ended.

During the early part of 1896 our iron and steel manufacturers will be engaged in filling many orders already on their books. Nor will they lack new orders in the new year. The impetus that the iron trade has received in 1895 will certainly extend into the immediate future. Demand may not in 1896 be what it has been in 1895, and prices may be lower than they now are, but a great shrinkage in either demand or prices is not probable. Prices may indeed rise. Nobody expects from any cause a recurrence in 1896 of the depressing conditions of 1893 and 1894.

The abnormally low prices which prevailed in 1893 and 1894 and down to the second quarter of 1895 should not again be possible. During the recent depression the best furnace coke that this country can produce was sold on cars at 85 cents per ton of 2,000 lbs., and the best Lake Superior bessemer ores were sold at less than $3 per gross ton delivered at Cleveland. These are leading raw materials in the manufacture of pig iron. If they had not been sold at the low prices mentioned, the prices of pig iron, steel billets, steel rails, and other iron and steel products could not have fallen so low as they did.

Now, what may reasonably be predicted of the more remote future of our iron and steel industries? I have shown how rapid and substantial has been their development since 1860, how courageously we have invested our capital in establishing new branches of these industries, how promptly we have adopted new methods of manufacture, and how quickly we have responded to the demand for iron and steel for new uses. It may be confidently assumed that our iron and steel manufacturers will not rest upon the record of present achievements; they will meet the mechanical and commercial problems of the future as they have met those of the past.

I assume that the protective policy of our fathers will be maintained in sufficient force to preserve the home market for the home producers of iron and steel, as well as for the producers of other products. Will that market continue to consume our iron and steel products in quantities sufficient to maintain our iron and steel industries in healthy activity, barring, of course, periods of industrial depression which no foresight and no legislation can wholly guard against? To be more exact, will the last years of this century and the early years of the next century—and we need look no further—witness a home demand for iron and steel comparable to that of 1895?

I think that there can be no doubt that the recently-developed use

of steel in the construction of public and private buildings will continue to grow from year to year. Not the least among the advantages claimed for structural steel is its cheapness. We will continue to turn out a large annual product of steel rails, but chiefly for renewals and extensions of track already laid, and not chiefly for the construction of new railroads, or of electric railways for local passenger traffic, important as both these sources of demand must continue to be. There will be an increased demand for iron and steel for use in the building of cars and locomotives and for the various appliances of electric roads. Steel will continue to be a favorite material in bridgebuilding. Whether we greatly increase our naval equipment or not, we will continue to require large quantities of steel in the construction of lake and ocean vessels. Our new tinplate industry will require continually-increasing quantities of steel from year to year, our steady increase in population of itself contributing largely to this result. The use of cast iron pipe and of wrought-iron and steel pipe must also increase with our increase in population. This increase in population will also enlarge the market for stoves, agricultural implements, and hundreds of other articles composed wholly or in part of iron and steel. Our aggregate consumption of iron and steel must certainly increase as the years roll on.

Except in periods of excitement like that which prevailed last summer, our capacity for the production of iron and steel will be greater than the home demand. This fact, joined to the cheapening of all iron and steel products through competition, has led many of our manufacturers to look to foreign markets to absorb our surplus products or to employ our surplus capacity. An examination of our export statistics for many years shows that this is a delusive hope. In 1871 our exports of iron and steel and of manufactures thereof amounted to $14,185,359; in 1879, to $14,223,646; and in 1886, to $14,865,087. Thus for fifteen years our export trade in iron and steel made no progress. After 1886 it increased rapidly every year, until in 1891 it aggregated $30,736,507. Declining to $27,900,862 in 1892, it has since increased, the figures for 1894 amounting to $29,943,729. In all these years the principal item in our export iron trade has been "machinery," which amounted to $10,512,576 in 1893 and $10,715,520 in 1894. The items of next importance are builders' hardware and sewing machines, which together aggregated nearly $5,000,000 in each of the years 1893 and 1894. Saws and tools, locomotives, and wire come next in the order named, each item amounting to over $1,000,000 in each of the years mentioned. In each of these years, low as our prices were, our exports of pig iron were less than $400,000 in value, our exports of plates and sheets were less than half as much, our exports of all kinds

of nails averaged about $500,000, and our exports of iron and steel rails averaged about the same amount. The remainder of the total exports of iron and steel and manufactures thereof in these two years was composed of a long list of miscellaneous articles, the direct product of our rolling mills and steel works forming an infinitesimal part.

It is evident that our iron and steel manufacturers, as contradistinguished from the manufacturers of machinery, hardware, saws and tools, sewing machines, locomotives, and other finished articles, have little to hope for in foreign markets under present conditions or those which have recently prevailed. The reciprocity treaties which were in force from 1891 to 1894 did not notably help them. Our very low prices in 1893 and 1894 did not notably add to the exports of previous years. The countries with which we had reciprocity treaties are very small consumers of pig iron, bar iron, plates, sheets, rails, and structural materials, while in other than reciprocity countries our low prices were usually met by the still lower prices of European ironmaking countries.

If we are ever to greatly increase our exports of iron and steel, or of many other manufactured articles that might be mentioned, we must first establish regular lines of steamship communication with other countries, as Great Britain and some Continental countries have done, and next we must establish commercial agencies in the leading markets which are reached by these lines. We must also complete the Nicaragua canal. All these helps must be the work of time. Even then, as in the past, we must depend for foreign customers rather upon the superiority of our products than upon their cheapness. Reciprocity treaties, which throw away revenue that the country needs, and which have confused the public mind in the effort to distinguish the difference between them and absolute free trade, offer no commercial advantages to our iron and steel manufacturers that are worthy of serious consideration.

It follows from what has been said that American iron and steel manufacturers must look almost entirely to their own country for the employment of the productive capacity of their iron and steel works, and that, if this capacity can not all be profitably utilized, some of it, as in the past, must stand idle or be abandoned. The fittest works will survive. For these there will be sufficient employment.

ARE AMERICAN RAILWAY RATES TOO HIGH?

By H. T. Newcomb.

EXCEPT between the comparatively few localities connected by waterways (and excluding, for the moment, transportation by animals), railways furnish the only means of transportation cheap enough to be practicable in connection with productive industry as now organized. Prior to their introduction, the market for surplus agricultural products was confined within narrow lim ts by the excessive cost of movement. Over one of the best of the old turnpikes it cost $1.00 in 1807 to transport a barrel of flour weighing 200 lbs. 74 miles from Columbia, Pa., to Philadelphia. It is now possible to ship 500 lbs. of flour by rail from Chicago to New York, 912 miles by the shortest route, for the same sum. The reduction from 13½ cents to 4⅓ mills per ton per mile is from a rate absolutely prohibitive, for the longer distance, to one at which the entire surplus product of an area greater than the whole of Europe can be profitably shipped.

The progressive reduction in rates since the introduction of railways, which has been very great, is best illustrated by comparisons between the prices of various commodities during successive periods and the rates contemporaneously charged for their transportation. The average export price of flour was $5.88 per barrel in 1880, and $4.11 in 1894, and the average rate from St. Louis to New York 84 cents and 50 cents respectively during the same years. Comparing prices and rates, it appears that in 1880 freight charges absorbed the value of 1 barrel in every 7, but in 1894 only 1 in every 8.22. The average export price of wheat during 1868 was $1.90 per bushel, and the average rate for its transportation by rail from Chicago to New York 42.6 cents, or 22.4 per cent. of the price. Although the price for 1894 was unprecedentedly low, being only 67 cents per bushel, or 20 per cent. less than during the lowest previous year, the decline to 12.88 cents per bushel for transportation from Chicago to New York was still greater, the rate for the latter year being only 19.2 per cent. of the price. The average New York price of mess pork during 1893 was $18.35 per barrel, or 83 per cent. of the average for 1867, while the cost of bringing it by rail from Cincinnati in the latter year was but 36 per cent. of that in the former. The average rate per ton per mile charged for the transportation of anthracite coal over the Lehigh Valley railroad during 1874 was 2.21 cents; 1880, 1.43 cents; 1885, 1.22 cents; 1890, 0.84 cent; and during 1893, 0.82 cent. Compar-

ing these rates with the annual average prices of anthracite coal in Philadelphia, as given by the American Iron and Steel Association, it appears that the cost of transportation would have doubled its price at a distance of 206 miles from Philadelphia by rail in 1874, at 336 miles in 1885, and at 476 miles in 1893.

The average charge for carrying a ton of freight one mile *via* thirteen of the most important railways in the United States during 1865 was 3.08 cents; 1870, 1.80; 1875, 1.36; 1880, 1.01; 1885, 0.83; 1890, 0.77; and 1893, 0.76 cent. These railways performed one-third of the entire freight transportation during 1893, and from the figures given it appears that 76 cents would pay for as much transportation over their lines in 1893 as could have been obtained for $3.08 twenty-eight years earlier. This reduction, amounting to three-quarters of the average rate for 1865, has been exceeded by that in the price of but few even of those articles in the manufacture of which new inventions have worked the most radical changes. For the present purpose of comparing freight rates with contemporary prices it is unnecessary to reduce currency rates (prior to the resumption of specie payments in 1879) to the gold basis; but in considering the absolute reduction in rates the proper allowance should be made.

The entire transportation performed by the railways of the United States during the twelve years ending June 30, 1894, was equivalent to moving 136,799,677,822 passengers and 807,935,382,838 tons of freight one mile. Had rates averaging as high as those of 1882 been collected upon this traffic, the railways would have earned $2,629,043,459 more than they actually received. Had the amounts annually saved by the public through reduced charges for moving passengers and property been applied to paying the principal and interest of the national debt, which on July 1, 1882, amounted to $1,463,810,400 (estimating interest from that date at 4 per cent. per annum, which is higher than the average actually paid), it would have been extinguished some time during the fiscal year 1893, and the surplus accumulated since that date would have amounted to nearly $700,000,000. The obvious answer to such an estimate as the foregoing is that the increase in traffic which has taken place during the last twelve years would have been impossible at the rates of 1882. Admitting the force of this contention, it is interesting to observe that, had the amount of traffic remained during each of the succeeding years what it was during 1882, the difference between the cost to the people of its transportation at the rates actually charged and the cost at those of 1882 would have amounted to a saving upon the part of the public of $1,452,148,093, or a little more than 99 per cent. of the amount of the entire national debt on July 1, 1882. Had traffic increased half as much as it actu-

ally did, the saving to travelers and shippers would have been $2,040,284,477.

The constant pressure for concessions in the price of transportation upon those railway officials whose duties include rate-making is enormous. A reduction of a few cents will often open new and valuable markets to the products of particular localities, and, if not immediately balanced by corresponding reductions in rates from other sources of supply, may enable their shippers to monopolize what was formerly a common market. Consequently a single reduction must often be met by numerous others from points widely removed and frequently in an opposite direction from the market. Competing shippers in the same locality are always endeavoring to obtain more favorable rates than those granted to their rivals, and thus secure an advantage which not infrequently amounts to the difference between a gain and a loss. The use of particular commodities is often limited territorially by the freight charges from the point of production to those of consumption; and, when charges are too high on certain articles, substitutes produced nearer the points of consumption, or carried at lower rates, are frequently used. Similarly, the charges for passenger transportation, by limiting the distance to which agents can profitably be sent and otherwise hindering personal communication, effectively prescribe the limits of practicable interchange of commodities. Naturally, then, we find the entire force of commercial competition, possibly the most tremendous product of modern civilization, arrayed in opposition to the efforts of railway managers to maintain their charges at profitable figures.

A very large portion of railway traffic is obtained in competition with carriers making use of natural waterways and canals. For example, the grain traffic from Chicago eastward can be obtained during the greater portion of the year only at rates low enough to prevent its going to the numerous lake and canal lines. It is not surprising, therefore, that the normal rate on this traffic by rail from Chicago to New York amounts to only about four mills per ton per mile, and that in times of particularly strenuous competition it has been temporarily as low as two mills. In addition, the deplorable tendency among traffic officials to seek increased tonnage without sufficient regard to the cost of handling it, coupled, as it is, with the frequently unfortunate lack of intimate connection between the traffic and operating departments, must be given considerable importance in any attempt to measure the forces that tend to reduce charges.

No one can investigate the history of railway charges in the United States without reaching the conclusion that they tend constantly toward a minimum, retarded only by the feeble effort of officials

who are are often more concerned to obtain traffic than to make the business of transportation profitable. This minimum is the point at which the revenue produced will pay operating expenses and leave something, however little, as a recompense to invested capital. Rates cannot go permanently lower than this, because, if they do, operation will be discontinued. That they tend toward it is clearly indicated by the record of decreasing returns.

Though the railway system of the United States increased from a total length of 114,712 miles in 1882 to 178,709 miles on June 30, 1894, or 56 per cent., the aggregate sum paid in dividends during the latter year was only $95,575,976, being $6,455,458, or 6 1-2 per cent., less than during the former. This did not result from a transformation in the form of capitalization, though the percentage of funded debt to total capital is somewhat larger at present than in 1882, for stock cap tal increased over 30 per cent. in the same period. It is obvious that so great a reduction in the average amount of interest paid on bonds could not be contemporaneous with a reduction in dividends, as the uncertainty of return indicated by the latter would naturally tend to increase the rate of interest demanded. Some decrease, however, has taken place, as is shown by the fact that an increase of 72 per cent. in the aggregate of funded debt from 1882 to 1893 was accompanied by an increase of but 55 per cent. in the amount of interest paid. During 1871 railway dividends throughout the United States averaged $1,265 per mile of line operated; this average has steadily declined to $988 in 1881, $565 in 1891, and $557 in 1894. During the year ending June 30, 1894, railway stock having a par value of $3,660,150,094, or 63 1-2 per cent. of the total, received no dividend,—a larger amount, both actually and relatively, than during any year since the Interstate commerce law was passed. In the same year no interest was paid on 14 per cent. of all mortgage bonds, 12 per cent. of miscellaneous obligations, and 87 per cent. of income bonds. On the same date 192 railway companies, operating more than 42,000 miles of line and representing one-fourth of the total railway capitalization, were in the hands of receivers. During the three years ending December 31, 1894, receivers were appointed for railways having a total length of 46,873 miles capitalized at $2,534,529,000; and 9,178 miles, capitalized at $494,821,000, were sold under foreclosure. From January 1 to July 1 of the present year these totals were increased by 2,409 miles capitalized at $149,615,000 and 2,396 miles capitalized at $100,941,000, which, respectively, went into the hands of receivers and were sold under foreclosure. According to the preliminary report of the statistician of the Interstate commerce commission for the year ending June 30, 1894, the income of the

railways in a section including 52 per cent. of the area of the country did not produce enough above the actual cost of operation to pay their fixed charges during that year.

These statistics of decreasing returns to investors, financial disaster, and widespread insolvency clearly indicate that the present railway charges are not too high, unless it is desirable to reduce all railway corporations to a condition of uniform and hopeless bankruptcy, even if they do not demonstrate, as might be urged with some evidence of justification, that the returns now produced by railway rates are actually lower than is reasonable and just.

There is no public interest which demands that railway rates shall be so low as to be unremunerative. Too low charges invariably result in the speedy impairment of railway service through the deterioration of road-bed and equipment and the reduction of the efficiency of the safeguards against accident usually provided, thus increasing the danger to person and property. The expenses due directly to handling traffic and moving trains are much less elastic than those incurred for keeping up the quality of track, rolling stock, and signaling apparatus; and, when depleted revenues enforce upon railway managers the necessity of immediate retrenchment, the latter are most likely to suffer. Thus, when, during 1894, reduced traffic, low rates, and dwindling earnings required a reduction of 93,994, or nearly 11 per cent., in the number of men employed by the railways, nearly one-third of the entire number was taken from trackmen, their number being reduced 16 1-3 per cent. The decrease in the number of employees assigned to the maintenance of way and structures was 16 per cent.; in those assigned to maintenance of equipment, 13 1-3 per cent.; while in those assigned to the work of conducting transportation it was only 8 per cent. During the same year the expenses of operation were reduced 11 2-3 per cent. as compared with the previous year. Of the total decrease of $96,506,977 51 per cent. was taken from the expenditures incident to the maintenance of way, structures, and equipment, though these combined ordinarily constitute only about 37 per cent. of the total expense of operation.

Though expedients like the foregoing will frequently be resorted to, and interest and dividends paid by reducing the quality of the service rendered, they are merely temporary and generally extravagant, as physical deterioration soon reaches a point beyond which it may not be allowed to go, and final restoration is then found to cost much more than the total of the amounts which should have been regularly expended for maintenance. Unless revenues can be increased, the cost of such restoration must be taken from the return to investors, or met by new loans, and bankruptcy is the usual and natural result.

The frequent failure of railway enterprises to prove remunerative results in enhanced difficulty attending efforts to secure capital for the construction of new and often much needed lines, and in the exaction of conditions which afford at least a chance of extraordinary profits as an offset for what is regarded as the extra-hazardous nature of the investment. This opportunity for large returns very often takes the form of an excessive discount on the securities offered or—what is much the same thing—a large stock bonus to accompany sales of bonds, these being among the most frequently deprecated methods of "stock-watering."

Practically, it may be declared that the public, considered as distinct from railway owners, must finally pay for all the transportation it receives, and that too low rates between particular points or during a particular period are not desirable, because, if for no other reason, they will inevitably be offset by too high rates between other points or during another period. Nor is this conclusion, as might appear, entirely satisfying to present railway owners, for, long before the period of compensation arrives, their interest may have been destroyed by insolvency, bankruptcy, and foreclosure.

It is apparent, then, that, considered from any reasonable standpoint, the present level of railway rates is too low rather than too high. It is, no doubt, possible to conceive conditions of operation and management different from those now governing, under which economies could be devised radical enough to render much lower rates than those now in force both practicable and profitable. There are many particulars in which railway management as currently practised is extravagant and wasteful, but they are, without material exception, the direct result of the conditions imposed by public sentiment or legislative enactment. Just as long as the public sees fit to impose upon reluctant railway owners and managers the burden of unnatural and needless competition, which is beneficial to no one unless it be to soliciting agents, ticket scalpers, and other railway parasites, it should accept without murmuring the enhanced charges which it must pay for transportation, and the frequent losses from business depression of which railway bankruptcy is a prolific cause.

The various enactments of State legislatures intended to erect obstacles in the path of railway consolidation, the numerous provisions against the union of competing or connecting lines contained in railway charters, and, above all, the Interstate commerce law with its obnoxious anti-pooling section, have all had the uniform effect of forcing upon railway managers objectionable and non-economic methods, and of compelling the public to accept the alternative of charges higher than would be necessary under better conditions or of seeing

the greatest agency of modern civilization reduced to hopeless insolvency.

Authentic statistics of the amounts wasted in the struggle for traffic between rival railways are exceedingly difficult to obtain, as the efficiency of most of the methods resorted to in the effort to divert traffic from rival carriers depends very largely upon the degree of secrecy attained in their execution, and for the further reason that many of these practices have been rendered illegal and penal by statute. Among the most frequently deplored results of competition is the practice of paying large commissions to influence the routing of traffic in favor of particular lines. The abolition of this practice, which has been a prolific cause of "rate-wars," has been often attempted, but it has never passed into entire disuse, and, as long as competition continues, will probably be one of its ordinary weapons. According to a report made by the Interstate commerce commission as the result of a special investigation of the subject, nine railways expended the sum of $1,097,130 for commissions during a single year.

The multitude of outside agencies and travelling and other soliciting agents involves another considerable expenditure that is solely due to competition. Their only object is to secure passengers and freight for their respective lines, and their cost is so great, even during seasons of comparative harmony, that it has often been found necessary to restrict their number by contract.

The economic waste arising from the competition of long, circuitous, and expensive routes for traffic that would naturally go by more direct and consequently cheaper routes is incalculable. Freight traffic between New York and New Orleans furnishes a ready example, though not by any means an extreme instance of this form of extravagance. It is actively sought by numerous lines operating entirely by water, or by water to the ports of Norfolk, Savannah, Charleston, etc., and thence by rail; and the rates obtainable are in consequence extremely low. Yet, in spite of this fact, nearly one hundred all-rail routes are known to seek actively to secure it. Of these the shortest and most direct is by way of Philadelphia, Baltimore, Washington, Lynchburg, Bristol, and Chattanooga, the entire distance being 1,340 miles. In contrast with this, the longest route, involving a haul of 2,051 miles, is by way of Buffalo, New Haven, Indiana, St. Louis, and Texarkana. Estimating the cost of running a train these distances at the average cost per train mile given by the statistician of the Interstate commerce commission in his latest annual report, the cost for the shorter distance is $1,431 and for the longer $2,190,—an excess over the minimum of necessary expenditure, for each trainload carried over the longer route, of $759, or 53 per cent. This illustration is

fairly typical of the entire system of competitive railway transportation. While it may be true that the shortest is not necessarily the cheapest route, it cannot be doubted that a considerable saving would accrue from forwarding all traffic over whatever routes should be found, after careful experiment, to be the cheapest; but this can never be fully accomplished until the ruinous competition of to-day is restricted.

Competitive train service, both passenger and freight, is also a fruitful source of extravagant expenditure, which is not accompanied by any corresponding increase in the accommodations offered the travelling and shipping public. The cost of moving a passenger train from Chicago to Omaha at the average cost per passenger train mile for the roads operating between those points reported by the Interstate commerce commission is $4.23, and, if their number could be reduced one-half, which appears by no means impossible, the annual saving would amount to $1,499,958.

Very similar causes result in a failure to utilize rolling-stock equipment to anything like its full capacity. The amounts wasted in the construction of cars and locomotives that would be unnecessary if rolling stock were used to its full capacity can scarcely be estimated. That it is considerable is as evident as that the practice of light loading is the direct result of competition.

Railway managers have attempted in many ways the abolition or adequate restriction of competition, but no method ever devised, short of actual consolidation, has proved as effective and satisfactory as that somewhat erroneously termed "pooling." Against this custom, when it existed, was directed much popular antipathy, which was fostered and encouraged by every demagogue who saw advantage to his personal interests in availing himself of the strength of an unreasoning prejudice, and it has been forbidden by State and national legislation; but it is now coming to be universally recognized that evidence justifying such popular distrust and suspicion is wholly wanting.

AN ENGINEER'S LIFE IN THE TROPICS.

By Charles P. Yeatman.

AS a rule, it may be said that an engineer, in going to the tropics, risks physical and moral bankruptcy for the sake of bettering his financial condition. Of course, temperature and climatic conditions vary greatly with the height above sea-level, and what is true of the low land, with its swamps and tropical jungles, does not apply to the mountains and high plateaus, which have rapid drainage, and cool atmosphere, and are out of the reach of the dreaded yellow fever. Higher still, we reach an altitude which gives trouble to many on account of the rarity of the atmosphere.

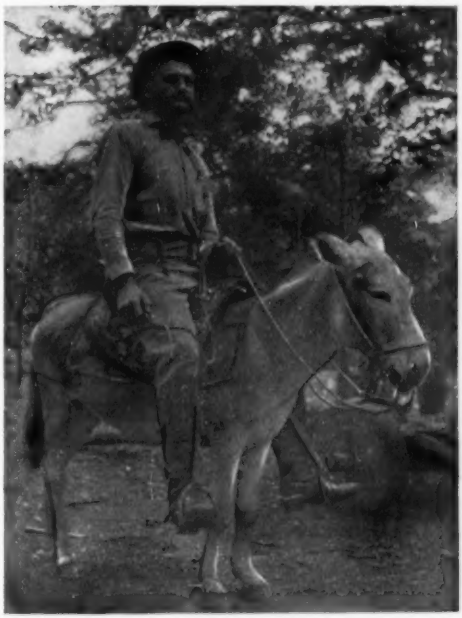
It has been stated on good authority that yellow fever is never endemic higher than 1,500 ft. above the sea, but under favorable circumstances, where rapid transportation exists between a coast town and one in the mountains, sporadic cases will appear so frequently in the high town that the germs become acclimated in time, and take up their permanent residence in an altitude of at least 3,000 ft.

The safest place for the foreigner in the tropics lies between 3,000 and 6,000 ft. above sea-level, but even at that height irrigation, that artificial swamp-maker, may bring miasma to his door, and thoroughly weaken his system and impoverish his blood. At the height of 8,000 ft. some persons do not have a continuous week of perfect health in years; yet a few days in a lower altitude gives relief. At over 10,000 ft. many persons are affected by shortness of breath on exerting themselves, if not by palpitation of the heart.

As these countries first need railroads to the interior from the seaports or points on navigable rivers, the engineer's experience is very apt to be on comparatively low land. Even when one resides on high land in the tropics, New York insurance companies charge 46 per cent. more to insure his life (supposing him to be 25 years of age) than they would if he lived twenty-six degrees or more from the equator. At 40 years of age the extra premium is 37 per cent.

Concerning risks to life in low tropical districts, the following extract from a letter of instructions to the agent of a first-class insurance company may be of interest.

"If the applicant who is going to the low lands is entirely unacclimated to tropical countries, or to be much of the time in the low land, or, indeed, if he is to be any of the time during the hot portion of the year in places below 1,000 ft. above sea-level, his acceptance at all would be doubtful, because a costly experience has shown us the



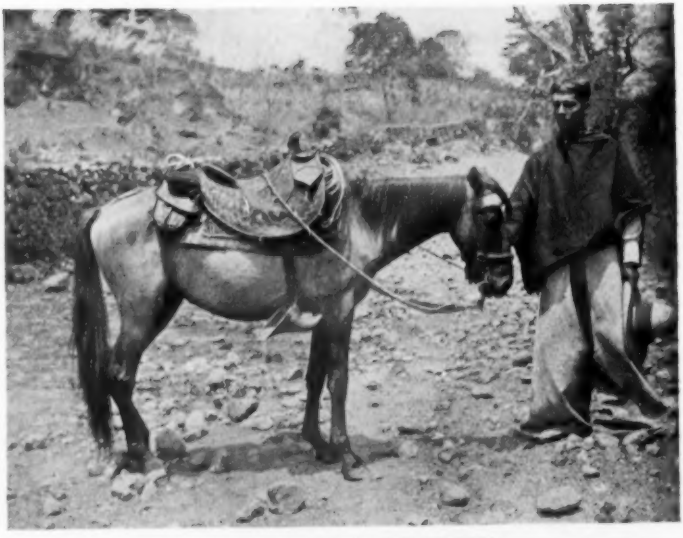
A MOUNTED ENGINEER.

danger of accepting persons going from high northern latitudes to reside in the tropics, away from the restraint of their families, and where, in the event of their being attacked by sickness, they will not receive the same attention that they would at home.

"If accepted at all, the case would have to be most favorable in respect to temperance and other qualifications necessary to make the risk above the average, in view of tropical residence, and the extra premium would be 4 per cent. the first year, 3 per cent. the second year, 2 per cent. the third year, and 1 per cent. the fourth year, over and above the tropical rate, as published in the table."

From my own personal experience, I can not say that the insurance companies make an unjust difference in their charges. In going over a list of eighteen foreigners with whom I was acquainted while on my first tropical work, I found that fourteen of them died within about ten years. I know nothing about the other four. Of these eighteen, sixteen were Americans and two were Englishmen.

It is commonly said by foreigners who live in the tropics that it is necessary to drink a large amount of liquor in order to preserve health. With all due respect for the honesty of such opinions, I must enter a decided protest against them. While admitting that a limited amount of liquor for a short time may stimulate the system enough to enable it to cast off contagion temporarily, it must be remembered that, to be efficacious, the amount must be increased as time passes, until the remedy itself may become more to be feared than the disease. The natural ability of the constitution to resist illness becomes undermined

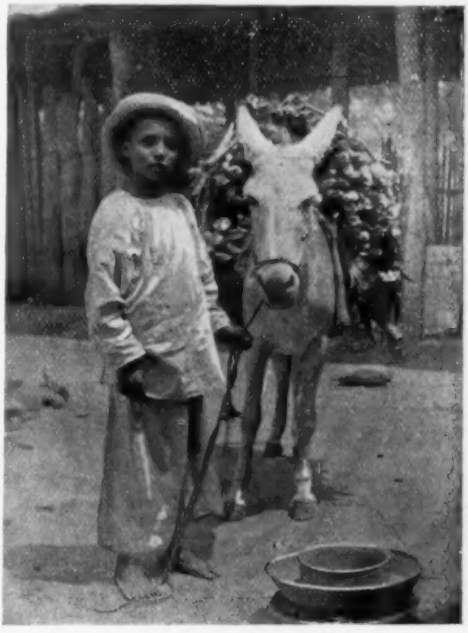


OUR FRONT CHAINMAN ON FEAST DAYS.

OUR MARKET BOY.

by a steady and excessive use of alcohol, so that, when a remittent fever comes, and the stomach refuses to retain the alcohol, there is apt to be a collapse of the patient.

While this is true of liquor taken continuously as a medicine, it is even more dangerous when taken recklessly to drown fear. The native of the tropics who was born and reared on high mountain land has more reason to dread the fevers of the low lands and coasts of his own country than has the foreigner from the temperate zone. The former never in his life felt hot weather, and his first experience is likely to have a very weakening effect, while the latter has probably experienced more heat during a part of every summer of his life than he will find in the tropics.



TWENTY CENTS WORTH.

The richest and largest cities in the tropics are often in the interior, at a considerable height above sea-level, and not the least objection to foreign travel, to those living in such cities, is the fear of dying in the hot part of their native land, before getting out of it.

I remember that, shortly after arriving in the town of Girardot, on the Magdalena river, I had to make a trip of about forty miles to a town in the interior. On the way I met an intelligent looking traveler from the "cold land," as they call it, who was hardly able to sit on his mule, and was very hilarious. At the next tavern I inquired about him, and was told with a smile that he was a doctor from the interior, who was on his way to Europe, and was so afraid of the "hot land" fevers that he intended to keep drunk until he was well on the ocean, as the surest means of preserving his health.

BAMBOO FALSEWORK.

PILE TRESTLE—HONDA.

On my return two days later the efficacy of alcohol as a panacea for fevers had been already settled in his case. He had been buried that morning, and his effects were in the hands of the town authorities, who had already notified his friends by telegraph. He arrived at night, ate and drank plentifully, and woke up in the morning under the influence of both liquor and fever. As the fumes of the former died down, the delirium of the latter took their place, and at daybreak the next morning he was buried. His journey through the low land had only begun, for he died at twelve hundred feet above sea-level, and seven hundred miles from the coast, which he would have spent ten days in reaching. This was by no means a solitary instance during the two years which I spent in that part of the country. On the other hand, those who passed through soberly and in order escaped burial, at least.

The difficulties in the way of the civil engineer in the tropics are apt to be many and various. Well I remember my first official trips for construction work on a Colombian road. Five miles of track were said to have been laid, four miles of grading extended beyond it, a contractor was ready with men to continue the grading, and I had orders to put in stakes for the earthwork.

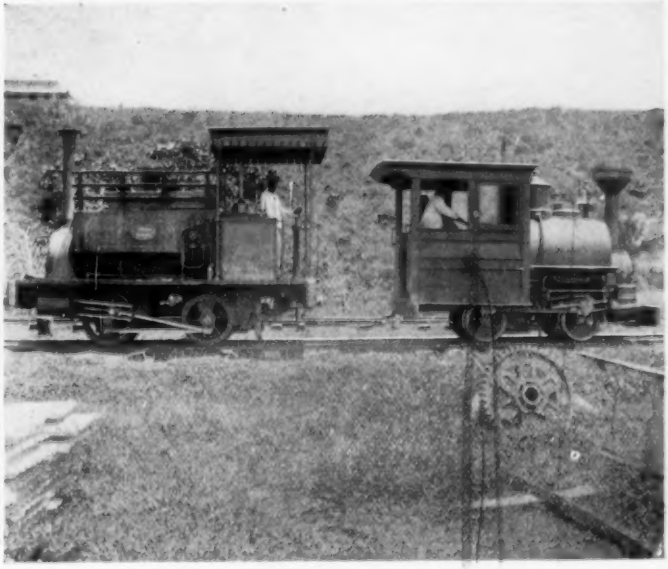
ALONG THE MAGDALENA.

After the first meal of the day, which is a cup of coffee and a piece of dry bread at six o'clock, I expected to find a train, or a hand car, or at least, a push-car, ready for the trip as far as the rails were laid. I was a little surprised to find a couple of mules, saddled and bridled, for my rodman and myself. It then transpired that the track was not navigable even for push-cars, for the ties were so rotten in many places

MULE-ROAD BRIDGE, WITH CORRUGATED IRON ROOF.

THATCHED BRIDGE OVER THE NUS RIVER.

HERE BEGINS THE TRAVEL BY PACK-MULES.



THE "COFFEE POT" AND THE "INKSTAND.

CEMETERY IN HONDA, COLOMBIA.

THE PLAZA—HONDA.

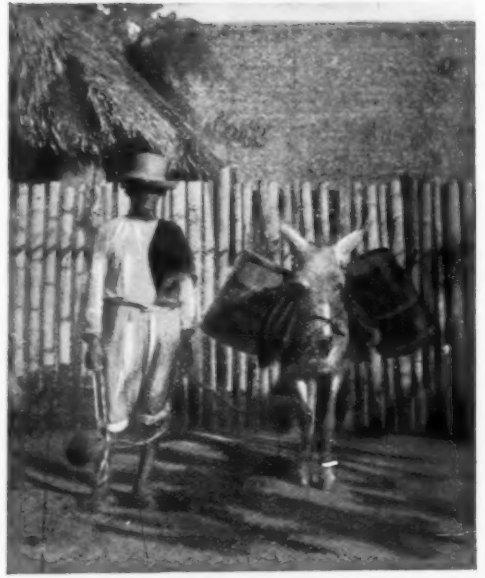
that the spikes no longer held, and the 35-lb. rails had a bad habit of spreading and letting the car drop in between them.

I soon learned what a serious hindrance this would be to the progress of the car. The track was the only road for cattle and mules coming from the interior, and an impenetrable thicket walled in each

RUINS OF CONVENT. DESTROYED BY EARTHQUAKE OF 1805.

side to the very ends of the cross-ties; so there was no choice for animals but to walk between the rails. This sort of traffic was so constant that the spaces between the ties had become deep mud-holes filled in part with water, thanks to the rainy season, which was then on in full force. Frequently the soft mud in these holes was too deep for the draft of the mule, and he made a rainbow of his spinal column to reach bottom on both sides of a tie at once. If that was not successful, he would balance for a moment on the tie, then kick up his hind feet till he almost stood on his head, and in that position would attempt to get his rear feet into the same hole in which his front feet were planted. If he succeeded, he would gather his energies together, and make a buck upward, like the mustang in Buffalo Bill's show; only he would open out in the air with the evident idea of getting his fore feet on the other side of the next tie. At times he would become desperate,

THE OLD COOK.



WATER FOR SALE.

WHERE THE BREAD WAS BAKED.

AN INDIAN MAKING STRING.

TROPICAL FOLIAGE.

A RAINY DAY.

and attempt to walk on top of the ties, but quick and sure disaster always followed.

Soon we arrived at a pile trestle over a narrow stream with perpendicular banks. A single line of plank twelve inches wide, spiked to the ties in the center of the rails, extended the length of the trestle. When my mule arrived at this point, he began to climb upon the plank, whereupon I slipped down into the mud. The mule stopped, and my companion told me that that animal would not cross a trestle without a man on his back, and that his own mule would never go across first. I looked at the water twelve or fifteen feet below; it was evidently deep, and the current swift. The ties were two feet apart and about six feet long. The plank was wet and slippery, and I thought that there must be either a misunderstanding or an attempt at a practical joke.

It might be well to explain here that I knew very little Spanish, and my comrade just as little English, and what either did know he did not pronounce as the other was accustomed to hear his native tongue spoken. In fact, I had spent the greater part of one evening learning from this same young man what I thought were Spanish words, until by chance I discovered that he thought I was finding out how much English he knew, and he was giving me his version of my own language.

I tried to lead my mule gently over the plank and then to drive him; then Martinez tried to ride him over; but by that time he was stubborn and would not go, although his new rider was armed with spurs whose rowels were about the size of a small dinner plate.

We held a council of war, and decided to push the mules off the top of the embankment and force them to swim the creek. The first one landed in the bushes with his nose over the water's edge, but backed and tried to climb up the bank. Martinez meant to kick him on the shoulder, but aimed too high, and, as his foot came down, that big spur caught over the mule's neck in front of the saddle. The animal jumped forward, dragging my friend with one foot on high and the other hopping, until the spur strap gave way just as the mule plunged into the water.

After that I walked along the track and drove my mule ahead of me. At short intervals there were trestles to be passed, and there was a hard-fought battle with the mules at every one. This was all because I did not stay on that mule and let him carry me over the first bridge; but at that time such a feat seemed to me like a weak imitation of Blondin on the tight rope.

When we reached the end of the track, I hoped to ride in comfort, but I found that the regular mule road was a series of mud-holes with

ridges between them, just as if it had once had cross-ties on it. It was much more exercise to ride than to walk, whenever there was ground above the water to walk on.

We came to a deep-looking creek, with steep and slippery banks, where there was a choice between crossing on a slender log, which nearly touched the water, and trusting to the mule. My friend swam his mule across, but the beast, in climbing up the other side, fell backward on him; fortunately the water was deep, so that his sole injury was a wetting.

I tried the log and had reached the middle of it, when I remembered having seen a big alligator not far away, and fell off at once. I caught the log with my hands so that I got wet only to the neck, but, in my great anxiety not to discommode the saurian in his native element, I scrambled upon the log and out on the bank from which I had started, and then "cooned" across with my feet dragging in the water.

In crossing a veritable "Slough of Despond," my comrade's mule got mired, and threw his rider over his head, so that he landed at full length in the blackest of slimy mud. When he had splashed out on more solid ground, and clawed the mud off his face, he said some words which I was sure were Spanish.

We arrived at our destination just before sunset in a very demoralized condition. When we started that morning, I hoped to finish our work and return to our starting-point before night. We were informed that, before the grading, etc., was done for the railroad, parties at times spent three days in crossing those nine miles of swamp, the rainy season making some of the rivers impassable so suddenly that they were imprisoned between two streams and could not go forward or backward until the water fell. This was told with an air which said that now the trip was easy and commodious, but I could not help thinking how much more comfortable it might be made.

That night my friend provided me with the regulation floor bed,—a mat three feet by six,—a small pillow, and his own mosquito net. At first I refused the last, as it was all the baggage he had brought, but, when I saw that he was similarly provided for, my conscience was more easy.

I hoped to sleep well, although the ground under my mat was neither smooth or soft, but I soon found that I had bed-fellows, who did not propose to sleep. First came mosquitos, and then legions of larger insects, which ran over me, but did not bite, for which I was thankful. Then I discovered that I was the center of attraction for numerous rats, which ran around outside of my net, as if looking for a place to get in at me.

Once I was wakened by a rat running over my face, and, after chas-

ing him out, I carefully tucked the bottom of the net under the edge of the mat on which I lay. After that I slept till morning. Before I crawled out from under my net, I discovered why the rats took such a great interest in me. The inside of my net was covered with roaches, which had taken refuge there to escape from the rats, which are very fond of them.

It is the luck of many who go to the tropics to meet immense anacondas immediately on their arrival, and in many instances the serpents must have been brought a thousand miles or more from their abiding place in the Amazon valley to meet these bold hunters. In ten years' work in the forests, mountains, and plains of Colombia, I have met but three or four large snakes. The largest was thirteen feet two inches long, and six or seven inches in diameter. These snakes were considered perfectly harmless.

There are plenty of poisonous snakes, but people are not often bitten by them; I know of but one death from that cause. The chief engineer of the Bucaramanga Railway, an Englishman, was bitten on the bare leg while fording a creek bare-footed, and died from the poison.

That year (1893) was an unlucky one for foreign chief engineers in Colombia. The chief engineer of the Cauca Railway was drowned in the Dagua river, that mountain torrent of whose navigation Humboldt wrote that "each canoeman was a god, and each push of his pole a miracle," and the engineer of the Cucuta Railroad had the yellow fever twice, but survived it, much to the amazement of the citizens of that city, who seem to take a pride in the fact that chickens, hogs, cattle, and even mules, imported from this country, die of the yellow fever, with all its symptoms of black vomit, etc.

There are many excellent opportunities for investment of capital in Colombia, but, on account of the depreciated currency, it is not at present a Mecca for civil engineers without foreign capital to back them.

In Venezuela there is a little railroad leading from Lake Maracaibo toward the interior, which in 1892 paid a dividend of 25 per cent. and in 1893 dividends amounting to 40 per cent. of the first cost of the road. The road was built in the cheapest possible manner alongside of the mule-road, and traffic commenced almost at once, giving profit enough to gradually rebuild the old road and prolong it.

A small road near by, in Colombia, paid in the same years 9 per cent. and 13½ per cent., but on a capital which represented no outlay whatever to the stockholders. The road replaced a mule-road on which toll was collected, and the holders of $2,500,000 of stock were never called on for payments. This road was built by Colombian engineers, and had on it considerable expensive masonry.

ARE WE EDUCATING TOO MANY ELECTRICIANS?

By Henry Floy.

REMARKABLE electrical discoveries and a failure to understand the laws which govern electrical phenomena have combined to produce in the public mind an almost superstitious belief in the impossible, or, to put it mildly, a facility for considering the most commonplace fact a profound and fascinating mystery if only joined with the wonder-working word "electrical." As a result, public attention has been unduly attracted to and concentrated upon things electrical; the fad has been increasing, until it has become something more serious; it is a mania,—electro-mania.

As a result, the opinions and lives of many individuals are erroneously shaped, and the effects are becoming so marked that it seems time for those who realize the situation to set about correcting the existing misconceptions. To my mind there is urgently needed an educating of popular thought as to the possibilities of electricity and the business opportunities offered in electrical engineering. Such information must be conveyed by a simple and straightforward statement of facts and of the conclusions that may be logically drawn therefrom.

Having some time ago become convinced of the over-supply and continued over-production of electrical engineers, I wrote an article* setting forth some facts in this connection. I hoped that its publication would lead others to similar action, resulting in a dissemination of knowledge concerning the opportunities in electrical engineering and a discussion of the relative advantages of the different engineering professions. The hope has been partially realized, and at least two long and praiseworthy contributions have been made by Mr. Jas. A. Cahoon,† who seems to see the situation largely from my own standpoint, and by Mr. A. A. Atkinson ‡, who argues the opposite side of the question. Among other statements made by the latter writer is the following: "The time is rapidly approaching when every central-station lighting and power plant, and every form of electrical business,

* "The Advisability of Becoming an Electrical Engineer," *Electrical World*, April 14, 1894.

† "Training of the Electrical Engineer," *Electric Power*, January and February, 1895.

‡ "Opportunities of Electrical Engineering," *Electricity*, April 24 and May 1, 1895.

will have their consulting and installing engineer." Such a statement, it seems to me, misleads the public, for no more than each steam or water-power installation, does each electrical installation necessitate a consulting engineer. The electrical manufacturing business is daily tending to the production of more simple apparatus, which may be operated by those who are ignorant of electrical laws; consequently there is less and less call for the highly-educated theoretical man in the more usual practical applications of electricity.

Referring to my previous article, in which I showed that over twelve hundred young men are annually graduated as electrical engineers, Mr. Atkinson says: "I know personally that, in one or two institutions whose catalogues are quoted by Mr. Floy to show the great number of students in electrical engineering, at least six or eight times as many are at the same time registered in the law departments alone, to say nothing of medicine and other professional departments." Even supposing this were true in all the institutions to which I referred, what strength is there in such an argument? It would be just as sensible to say that because there are a hundred times as many bricklayers in the country as there are electricians, therefore the demand for electricians is not met, and will not be, until bricklayers and electricians are numerically equal. We are concerned, not with the ratio of electricians to other professional men, but with the ratio of electricians to the number of positions available.

Mr. Atkinson says that the fact that a young man cannot get more than $40 or $60 a month in the electrical field is not a good reason for advising him to "stay on the farm, or in the shop, or in the store, at $25 or $30 a month." If it were a fact that the young man who earns $25 or $30 on the farm or in the store could get $40 or $60 in the electrical business, we should all of us recommend him to change his vocation; but experience proves that to-day the average young man—I am not speaking of exceptional cases—will find, on entering the electrical business, that, instead of getting $25 or $30 per month, if that was his salary, he will more likely receive but $18 or $20. Any one acquainted with the salaries received by young men in the electrical business will bear out this statement.

While I can appreciate the situation of a father who, with a lot of boys "coming along," finds it an extremely difficult matter, in these days of keen competition, to aid them in the selection of a business career which holds out promise of success, it is neither just to one's self or fair to the boys to decide that they shall become electricians simply because public opinion believes that in this line of employment are to be found golden opportunities for securing fame and wealth easily and quickly.

It would be surprising to those who have not had the opportunity to learn to hear fathers and mothers give the reasons why their sons have entered upon the life of an electrical engineer. In many cases I have found that, because a boy showed enough interest and ingenuity to put an electric call bell in his home, it was considered that he had a "calling" to the life of an electrician, the fact being overlooked that the same boy had evinced an equal or greater interest in carpentry, stamp-collecting, or base ball, for any one of which he was better fitted.

The old definition of electricity, "an unknown substance acting in an unknown way," has been discarded. To-day as much is known of electricity and its law of action as is known of gravitation or the power of steam, and any one who has a fair amount of intelligence and is willing to exert the requisite energy may learn its *modus operandi*. Thus, while we can say with the editor of the New York *Sun*: "There always has been, and there always will be, a good chance of success in the world for any young man who is faithful, industrious, patient, earnest, and true," yet these points must be particularly emphasized, if the young man is to succeed in electrical engineering.

While it may be argued from an examination of college records that to-day a large number of men are preparing themselves, as thoroughly as possible, by long and expensive collegiate courses, for expected openings in electrical engineering, many of them, nevertheless, have entered upon these courses of study for no other reason than that they share the erroneous opinion that handsome incomes and glowing fame are sure to reward all those who secure electrical positions. The truth is that, in the majority of cases, these positions are no more attractive financially than a thousand opportunities in other and longer-established lines of business.

Feeling sure of the over-production of electrical engineers, and in order to secure some facts as a verification of my convictions, I sent two hundred and sixty personal letters to the present year's graduates in electrical, mechanical, and civil engineering, from Cornell and Lehigh Universities and the Massachusetts Institute of Technology. The letters were sent in the latter half of September. My idea was to secure statements which would show comparatively the number of positions secured by recent graduates in electrical, mechanical, and civil engineering courses, to ascertain whether influence was necessary to secure positions, and, finally, to determine the salaries paid in these positions.

While statistics on these points might not prove anything, they would be a strong indication of probabilities. Of course, it would be more interesting, and possibly more valuable, to have these questions

answered by men who graduated from college ten or fifteen years ago, and are well established in the line of work in which they will probably spend the remainder of their lives; but the impossibility of securing such information will be recognized, as men farther advanced in years have much more hesitancy about informing others as to their salaries and occupations.

The letter stated, in brief, that I desired to secure statements from recent graduates in reply to the following questions, the answers to which would be considered confidential:

1. Have you secured a position in the line of engineering since graduation?
2. Was this position secured through any relative?
3. Was this position secured through the influence of friends?
4. Of what does the work you are doing consist?
5. How many hours per day are you employed?
6. What salary do you earn per week?

The replies received were most interesting, courteous, and complete. They gave one an opportunity of becoming acquainted with, and an insight into, the character of some of America's recent and representative graduates in engineering, and the letters would prove valuable and instructive food for consideration by college professors. For example, the letters written by the graduates of one college were particularly noticeable as indicating their authors' lack of training in the use of good English. A number of the letters would make very interesting and helpful reading for young men about to enter the practical life of an electrical engineer. With the consent of the writers, I print extracts from three letters received from graduates in electrical engineering.

"I have made application by letter to about one hundred of the leading manufacturing and railway companies, consulting and contracting engineers, etc. Although more than one-half the letters sent have received kind attention and have been acknowledged, yet, from statements such as this: 'Our engineering force is now filled and more so,' I cannot but think that most of the positions secured must have been created through the influence of relatives or friends."

"After graduation, I wrote a number of letters applying for a position, but received discouraging replies. In these letters I mentioned nothing of shorthand and German. What I wanted was a start in engineering work; this is very difficult, as I know from my own case. I then wrote two more letters, in which, among other things, I mentioned my knowledge of shorthand and German, and also stated that I had had some experience in business. Both of these letters brought answers asking an interview. As a result, I have my present position. I believe

RESULTS OF INQUIRIES AMONG RECENT GRADUATES OF TECHNICAL INSTITUTIONS.

	CORNELL UNIVERSITY.			MASS. INST. OF TECHNOLOGY.		
	Electrical.	Mechanical.	Civil.	Electrical.	Mechanical.	Civil.
Letters sent	35	30	25	46	24	20
Replies received in per cents	31.4	34.3	48	69.5	33⅓	50
Of the writers heard from the following: Have Secured employment, per cent.	63.6	65.6	91.7	78.1	62.5	90
Secured employment in the line of work for which they studied, per cent.	45.4	66.6	91.7	65.6	62.5	90
Secured employment through influence of relatives. "	18.1	0	16.6	20	40	0
Secured employment through influence of friends. "	0	33.3	25	24	40	77.7
Average working day	8 hr. 42 min.	8 hr. 30 min.	8 hr. 15 min.	8 hr. 48 min.	9 hr. 22 min.	8 hr. 34 min.
Average pay per week	$9.70	$15.31	$13.65	$11.31	$14.12	$13.81
Average rate paid per hour on basis of 5½ working days per week	20.2 cts.	32.7 cts.	30.0 cts.	23.3 cts.	27.4 cts.	29.1 cts.

	LEHIGH UNIVERSITY.			TOTAL RESULTS.		
	Electrical.	Mechanical.	Civil.	Electrical.	Mechanical.	Civil.
Letters sent	27	17	36	108	71	81
Replies received in per cents	33.3	47.0	47.2	48.1	39.4	48.1
Of the writers heard from the following: Have secured employment, per cent.	100	100	82.2	78.8	75.0	71.8
Secured employment in line of work for which they studied, per cent.	88.8	87.5	82.3	65.3	71.4	87.1
Secured employment through influence of relatives. "	44.4	12.5	11.7	21.1	10.7	11.1
Secured employment through influence of friends. "	22.2	37.5	23.5	15.3	32.1	35.8
Average working day	9 hr. 12 min.	9 hr. 15 min.	8 hr. 34 min.	8 hr. 54 min.	8 hr. 56 min.	8 hr. 27 min.
Average pay per week	$10.64	$10.75	$12.69	$10.70	$13.52	$13.27
Average rate paid per hour on basis of 5½ working days per week	21.0 cts.	21.1 cts.	26.8 cts.	21.8 cts.	27.4 cts.	28.5 cts.

that technical graduates could more easily obtain positions, if they had something else to recommend them, in addition to their engineering education. Perhaps I would not have a position now, if it were not for my other acquirements."

The following is written by a young man on the Pacific coast, and states his own ideas of the conditions there:

"The situation of a young electrical engineer on this coast is decidedly different from that of one in the east. Although an enormous amount of installation work of a high character is now being done here, it is entirely in the hands of the two great manufacturing concerns in the east. Naturally they send out their own men to equip plants. Moreover, with one exception, there are no manufacturers of commercial dynamo-electric machinery on this coast."

Following are the tabulated and averaged results of the replies received. There is a table for the graduates from each college, and also a table of the total. In making up these tables, I have tried to be fair and strictly impartial,—not a difficult task, as the replies were usually direct and to the point; in only one instance was there a refusal to inform me as to salary.

Considering only the table of total results, which may be taken as a fair indication of the condition of the recent graduates in electrical engineering, it will be found that, while a greater per cent. of the graduates in electrical engineering secure employment, as compared with the other graduates, yet the fewest, relatively, secure employment in the line of work for which they had studied,—that is, in order to get employment, they had to take positions in which their electrical knowledge did not count. It will furthermore be noticed that almost twice as many men secure employment in electrical engineering through the influence of their relatives as in mechanical or civil engineering, while about half as many obtain positions through their friends as in the other two professions.

The working day averages about the same number of hours in each profession. Assuming five and one-half working days per week, it will be seen that the electrical graduate receives over twenty per cent. less per hour than the mechanical graduate, and twenty-three per cent. less than the civil graduate, who is the best paid of all.

THE LOCATION AND CONSTRUCTION OF DAMS.

By J. B. Johnson.

THE demand for artificially-raised water storage is rapidly increasing in all parts of the world. For irrigation, for power, and for domestic uses, unfailing supplies of water at commanding elevations can usually be secured only by the building of high dams across the outlets of great natural basins. The rapid multiplication of these enterprises, and the occasional failure of such constructions, with their far-reaching and disastrous results, give to this class of engineering works a perennial interest. In this article the present state of the science and art of dam-construction will be reviewed, with some suggestions of further improvements, and a few illustrations both of successful and of unsuccessful works of this class.

The conditions to be fulfilled by a dam are imperviousness and stability. It must intercept all flow, either through, under, or around it, and it must neither be overturned by the hydrostatic pressure, or washed away by the overflowing water, or undermined by the overfall or by seepage. At the same time it must be so designed as to pass the greatest floods, and to deliver the service-water as required.

Imperviousness in earthen dams is attained by means of a centrally-placed wall of masonry or of clay puddle, preferably the former, as shown in Fig. 1. To make a rubble masonry wall watertight is a difficult task. It requires a character of workmanship entirely beyond the standard of the ordinary stone-mason. It means a wall without any openings whatever. To build such a wall demands the constant exercise of the scientific imagination. As a rule, this faculty is not highly developed in the modern stone mason. He must constantly foresee the opportunity for openings, and provide against them. Both the stone and the cement mortar used are practically impervious, and yet the ordinary rubble wall will leak like a sieve. The slushing of joints should not be allowed. The stones should have no hollow spaces on their lower sides. All joints and spaces between the large stones of a course should be entirely filled with mortar flush with the surface of the course, and then smaller stones and spalls should be pressed into this mass of mortar. Such work should not be let by contract, and it should be thoroughly supervised and inspected. Thickness of wall is no insurance of imperviousness. A thin masonry core is preferable, since then more care is sure to be

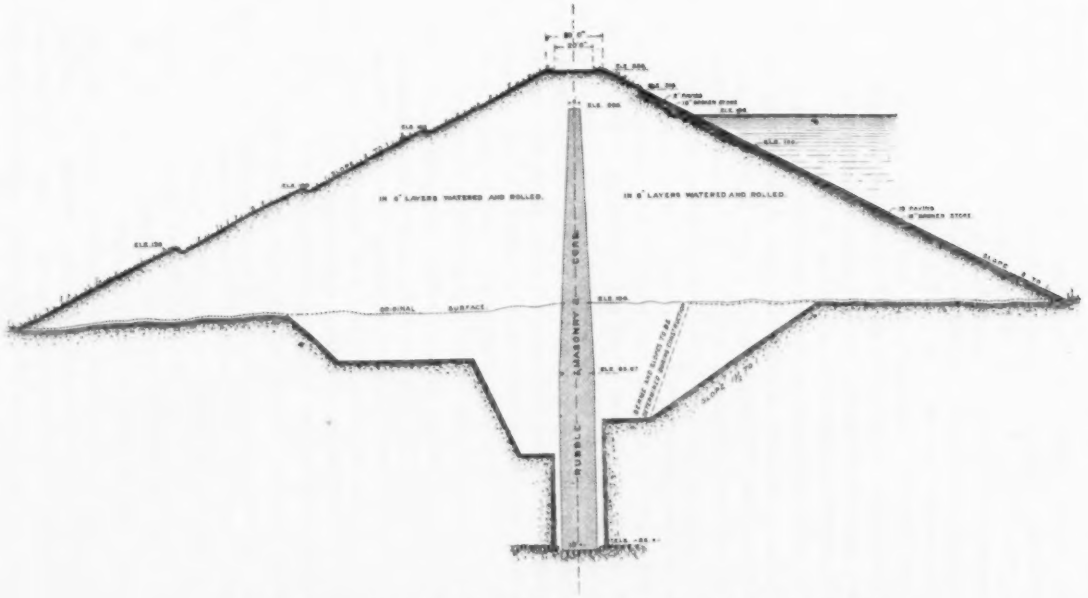


FIG. 1.—EARTH PORTION OF THE NEW CROTON DAM, SHOWING RUBBLE MASONRY CORE.

given to secure absolute solidity. A surface coating of portland cement mortar, washed with neat cement whitewash, well brushed on, would add additional security. Recently the core has been made of thin iron plates, which are coated with asphalt and set vertically in the center of a thin wall of concrete, this concrete and metal wall extending, as usual, below the natural surface to an impervious stratum below, and into the side hills to a like limit. With the present cheap price of iron, this is probably the best possible practice. The plates could simply lap a few inches on all edges, and need not be riveted. Plates one-sixth of an inch thick would serve for this purpose. This would cost about as much as six inches in thickness of masonry wall, and it would not require more than a foot or two of concrete on either side of it. Cracks in the masonry walls of the storage reservoirs of Paris have been repaired by strips of pure caoutchouc soldered upon the hot cement by means of a solution of rubber in benzine.

If a clay-puddle core is relied on, it should be mixed with gravel and the whole thoroughly moistened and mixed in a pug mill in order to solidify it and to make of it a perfectly uniform mixture. This should then be laid in six-inch layers and thoroughly rolled. If the clay could be obtained in a pulverized condition in a dry state, it might be spread in alternate courses with the gravel, and then thoroughly harrowed until completely mixed, after which the combined layer should be wet through and allowed to stand till it is in a condition to pack, when it should be effectually compacted with a heavy grooved roller. Here again the scientific imagination is taxed to foresee the possibility of openings and to provide against them. In such work plans and specifications are of little value compared to the work of the resident engineer and his inspectors. Too often the corporation relies upon the efficiency of the plans and specifications, prepared perhaps by an eminent engineer, and foolishly thinks to save a few dollars by reducing the force of inspectors or employing entirely incompetent men. This is like having a great general plan a campaign, and then engaging a few ignorant corporals to conduct the battle. We read, however, that Napoleon was always on the ground and did his own inspecting.

When the material of which the body of an earthen dam is composed seems well calculated to form an impervious embankment, the masonry or puddle core is entirely omitted. Then the whole bank is constructed with care, and an entirely satisfactory dam may result.

Imperviousness of masonry dams also requires the greatest care, however thick the masonry wall may be. An excellent precaution in this case is to clean out all the joints on the upper face of the dam, to a depth of some two inches, while they are still soft, and then, after

the dam is completed, or before the water is allowed to come upon it, point these up carefully with a rich portland cement mortar, one to one of cement and sand, pressing or driving this firmly into all such superficial openings. This will give as nearly an impervious sheet on the up-stream face as it is possible to obtain with masonry, since such a mortar is practically impervious to water. Laboratory experiments made by the writer on cement mortar disks two inches thick show that such a mortar, well compacted, is quite impervious under one hundred feet head of water. Mr. James B. Francis showed by experiment that ordinary portland cement mortar of one part cement to two parts sand was quite pervious, and in time transmitted some nine-tenths of the hydrostatic pressure upon it. This would seem to indicate that all the mortar joints of a masonry dam are subject to a lifting action, as this mortar commonly has three parts of sand to one of cement. In a recent paper Mr. John D. Van Buren recommended that this lifting action should be assumed to obtain throughout the entire body of the masonry, thus reducing the weight of all the masonry by sixty-two pounds per cubic foot. This would necessitate a very much greater width of base and a corresponding greater cost. Doubtless in many of the masonry dams now built this hydrostatic lifting action does occur over a considerable part of the lower horizontal planes of the dam, on the up-stream side; but to assume that it obtains over the entire section on every course is certainly to lean excessively to the safety side in making the computations. The proper solution would seem to be to obtain as nearly an impervious up-stream face as possible, and then leave all the joints in the body of the wall more or less pervious, so that a hydrostatic pressure here would be impossible. This would be accomplished by the pointing up of the joints on the water side with rich mortar, as described above. Doubtless the tensile strength of the cement mortar joints is commonly called into action as a result of the buoyant effect of this transmitted pressure. In the case of the highest masonry dam yet built, and the first one having a profile designed in accordance with scientific principles,—the Furens dam on the upper waters of the Loire in France, built 1862–6,—perfect imperviousness and stability were attained. This dam is subjected to a maximum water pressure of 164 ft. head, the dam itself being 184 ft. high above its foundation. Although it was built of rubble masonry, of stones from 2 to 7 cu. ft., and mortar joints from ¾ to 1¼ in., and no extra precautions taken in pointing up the joints on the up-stream side, yet the work was done so carefully and under such skilful supervision that no seepage through or under it has occurred, and a trench dug at the outer toe remained quite dry for four months with the reservoir full of water. So much for skilful execution. On the other hand, it is not uncommon

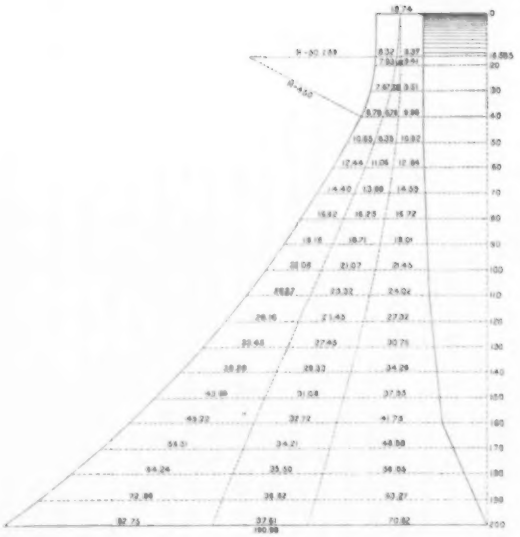


FIG. 2.—PROFILE FOR MASONRY DAM, 200 FEET HIGH.

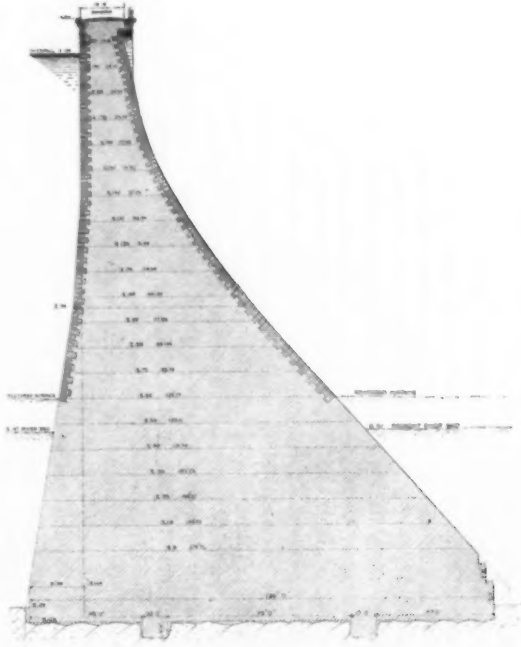


FIG. 3.—MASONRY PORTION NEW CROTON DAM.

in this country to see leaky reservoir walls, built of highly-dressed dimension stone, with ¼-in. joints. This very expensive masonry may argue skilful designing, but, if the execution be bad, no adequate return is obtained for the money expended. In general, however, the execution has been sufficient to insure both imperviousness and stability, for very few masonry dams leak badly, and many are absolutely tight. Out of fifty-five high masonry dams which have been built in this century only three have failed. One of these failures was due to a pile foundation; one to wretched construction causing it to leak like a sieve, and giving the lifting action of the water pressure on all the joints; and the third was the Bouzey dam failure, described later.

The slopes of earthen dams are so low, to prevent erosion, being usually about two horizontal to one vertical on each face, that there is no question of their stability, whatever their height. With masonry dams, however, the width is properly made the least which is consistent with stability. There is usually no danger of sliding outward. If founded on natural rock, it is set somewhat into the same, and is firmly attached to it by its cement bed. If resting on earth, it passes well below the surface, and hence is firmly imbedded against bodily lateral motion. The only question of stability, then, is that of overturning.

The first question is to decide whether or not to treat the dam as a solid mass. If the water does not find access to the horizontal joints, it may be so treated. This is commonly assumed to be the case. Since the best portland cement is now always used in these structures, there is no question of a masonry dam acting as one complete monolithic mass. As such, if the dam is straight, it resists the overturning action of the water by its dead weight alone. If resting on rock at the bottom, it is probable that the masonry is very firmly attached to it, so that the dam might really act as a beam protruding from the earth and laterally pressed or loaded; and this may explain why some dams do not overturn, when it would seem, from the principles of statics, that they ought to. However, it would not be safe to assume any such action.

Treated as a monolithic mass, therefore, but one which cannot resist an upward tensile stress on any horizontal joint, it follows that the center of pressure on each course must fall inside the middle third of the thickness in every horizontal plane. For, treated as one solid mass, if the center of pressure were outside of these limits, it may be shown by graphic analysis that there would be a tensile stress on the water side of the joint. Since it is desirable to make the thickness as small as possible to satisfy this requirement, it is common to let the line of resultant thrust fall just one-third the thickness from the outer (downstream) face of the dam.

It is a remarkable fact that previous to 1860 no masonry dam was ever built with any correct theoretical analysis for dimensioning its thickness. MM. Sazilly and Delocre of France made such analyses in 1853 and 1858 respectively, and, based on the true theory, then first made known, the Furens dam was built. Thus both the theory and the practice of masonry dam construction jumped to practical perfection in the first application of the theory, and the Furens dam still stands unsurpassed in economy of section, in height, in imperviousness, and in stability, for it is apparently able to stand for all time. The new Croton dam, now building, will exceed it in height, when completed, its height being 240 ft. above its rock foundation, and 150 ft. above the bed of the stream. The profile of Mr. Edward Wegmann, for a masonry dam 200 ft. high, is shown in Fig. 2, and that of the new Croton dam in Fig. 3.

Notwithstanding the fact that French engineers first put the building of masonry dams on a rational basis, they have sometimes violated these rules. Thus the Bouzey dam near Epinal, built in 1881 to a height of sixty-five feet above its foundations, had so slender a profile given to it that the line of pressure fell well outside the middle third. Soon after it was filled, it slipped bodily more than a foot on its foundations, and was badly cracked. It was repaired in 1889, but, although known to be dangerous, it was allowed to fill with water, and it failed by overturning on April 27, 1895, resulting in the loss of one hundred and fifty lives. Evidently water found its way into the horizontal joints on the up-stream side, where these joints were subjected to a considerable tensile stress, and this upward pressure of the water was sufficient to destroy all its moment of stability.

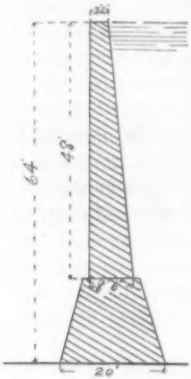


FIG. 4.—PROFILE BEAR VALLEY DAM.

In order to obtain stability at a less cost, masonry dams built in a deep, narrow defile or cañon, with substantial rock sides, are sometimes arched up-stream by giving them a circular form in plan. The determination of the reaction forces at the sides and bottom, in this case, and thence the stresses in the masonry, depends altogether on the deflection or movement of the dam from the water pressure against it, and on its rigidity vertically and horizontally. Since the bottom courses are rigidly attached to the foundation rock, they can, of necessity, offer no arch resistance, but, as the upper courses are deflected downstream, being arched up-stream, the horizontal arch comes into action to

resist such a movement. Evidently this arch action will be greatest at the top of the dam, where the water pressure reduces to zero, since the outward movement here is the greatest. It will also be greater as the thickness of the dam is less. That a thin dam so constructed does receive a sufficient support from the arch action to sustain it is evidenced by the profile of the Bear Valley dam (Fig. 4),

SITE OF NEW CROTON DAM; RIVER DIVERTED; SIDE HILL EXCAVATED; BEGINNING OF DEEP EXCAVATION IN BOTTOM OF VALLEY.

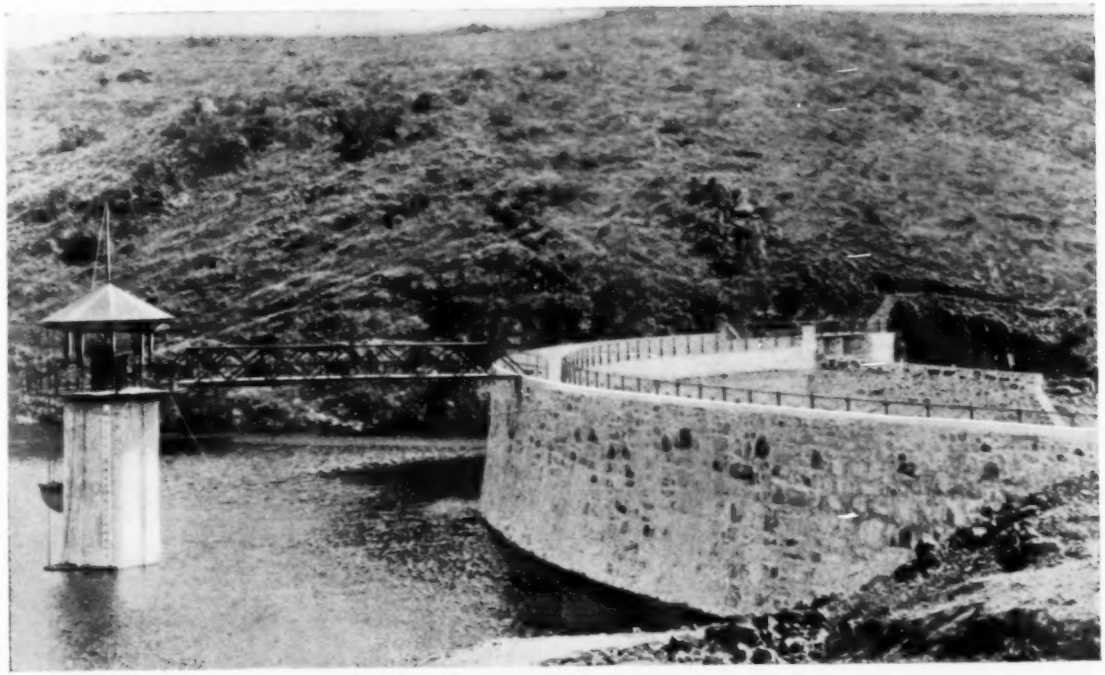
which has stood since 1884. Its length at top is 270 ft., and its radius of curvature is 355 ft. At the center the deviation of the dam from a straight line is about 27 ft., this being the versed sine of the subtended angle. The extreme attenuation of this section, being only 38 in. in thickness at top and 102 in. at a point 48 ft. below, has no equal; but it was forced upon the engineer as a matter of economy. It was built for the purpose of developing the country by means of irrigation, and all the cement and other supplies had to be hauled by teams one hundred miles over two mountain ranges and across a desert. Under such circumstances some risk can be allowed. Since the increase in volume, from increased length, of a curved dam over a straight one is never over five per cent. in any practical case; and since either the volume of masonry may be greatly reduced for a given factor of

BEAR VALLEY ARCHED MASONRY DAM, CALIFORNIA.

safety, or for the same volume of masonry a much greater factor of safety may be had; and, furthermore, since a curved dam presents an appearance of having greater strength and is more beautiful, so satisfying at once the æsthetic taste and sense of security,—there would seem to be every reason for making all masonry dams occupying narrow valleys with rocky sides of the curved form. The most noted example of such a combined gravity and arch profile is that of the Sweetwater dam in southern California. The dimensions of this dam are as follows: thickness at base, 46 ft.; thickness at top, 12 ft.; height, 90 ft.; radius of arch at top, 222 ft. The upper face batter is 1 to 6 to within 6 ft. of the top, thence vertical; on the lower face it is 1 to 3 for 28 ft.; 1 to 4 for 32 ft.; thence 1 to 6 to the coping. The line of pressure would fall at the center of the outer third for water up to the top of the dam proper, if it were straight, but in January, 1895, a flood discharge ten times the maximum provided for in designing the waste weir caused the water to rise twenty-two inches over the parapet wall and five feet above the highest level for which the dam was designed. If the dam had not been curved, it would doubtless have gone out at this time. The dam was subjected to this cataract action for a period of forty hours, but was in no wise injured by it. A trench was excavated by the overflow beyond the outer toe of the dam, and some of the conduit pipes were washed out, but the dam itself was entirely uninjured. Precautions have since been taken to increase the wasteway, and also to lay additional outlet pipes in a lateral tunnel around one end of the dam to prevent a repetition of the occurrence.

The objects sought in the location of a dam are: (1) the storage of the greatest quantity of water at the least cost of dam, ground, and conduit to bring the water to its destination; (2) favorable material to serve for the foundation of the dam; (3) a satisfactory means of passing the flood waters.

To satisfy the first requirement a large natural basin is sought, surrounded by hills of sufficient height, and with a narrow outlet with rock sides and bottom across which to place a dam. The storage capacity is readily computed from a good contour survey of the basin, which, if made by the transit and stadia method, will be found to cost very little. The character of the foundation is determined by sinking wells, or pits, to the natural rock in a line along the line of the proposed dam. Boring should not be relied on for this investigation. The sources of supply for suitable clay and gravel, if the dam is to be an earthen one, and for rock and sand, if it is to be of masonry, are also carefully determined, and the cost of transporting cement and other supplies estimated. From all such definite information the financial problem may be worked out. The second and third conditions are questions of engi-



SWEETWATER ARCHED MASONRY DAM, SOUTHERN CALIFORNIA.

neering, and, if a satisfactory solution is found, the project may be allowed to proceed to its execution.

If a suitable foundation, sufficiently impervious and firm to carry the proposed structure, cannot be found, the site must be condemned without further question. An example of what may happen to a masonry dam or reservoir wall which has been placed on an insecure foundation was lately given in the case of one of the division walls between two of the settling basins of the new St. Louis waterworks, after a washout had occurred. These walls are 8 ft. wide and 15 ft. high, and rested on a bed of concrete 15 ft. wide and 4 ft. thick. The sub-foundation is a river silt deposit, being a varied mixture of sand and clay. Reliance was placed on the imperviousness of the bottom linings of these basins, which consisted of 18 in. of well-rammed clay puddle, and 6 in. of cement concrete, laid in blocks 7 ft. square, with asphaltum joints. The rupture occurred suddenly, on October 12, 1895, one basin being full and the other entirely empty, the ground-water lifting bodily an area of bottom about 100 ft. square. The fact that the stone wall stood unsupported, without visible depression, on a span of 61 ft., argues well for the character of the masonry. The wash-out must have been caused by some porosity of the bottom linings of the basins.

A satisfactory means of passing the flood waters is not always easily found. If it is desired to make the dam of earth, it becomes absolutely necessary to pass all flood discharge around and not over the dam. Inadequacy of such flood passages has been the direct cause of nearly all failures of earthen dams, that of the South Fork dam, above Johnstown, in 1889, being the most notable in recent years. While the maximum flood discharge can never be predicted, engineers have certain well-defined means of estimating such matters, based on known climatic conditions of the region and a knowledge of the topographical features of the drainage basin in question, so that, by applying a reasonable factor of safety, for extraordinary floods, the outlet may be made large enough to insure the safety of the structure. Furthermore, they are able to compute almost exactly what the discharging capacity of any given outlet is, so that no part of the solution of this problem need be a matter of guesswork. In the case of the South Fork dam, although the outlet weir was entirely too short for the purpose, the outlet channel below this weir was so reduced in size as to limit its capacity to only fifty per cent. of that of the weir. This was due to simple ignorance of the laws of flowing water, but, as no civil engineer had anything to do with the work, the failure reflects no discredit on the profession.

If the area and topography of the drainage basin is known, and if

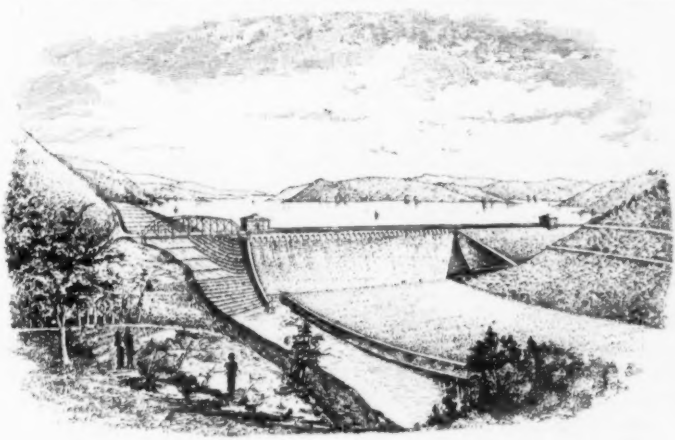
TITICUS DAM (CROTON SYSTEM) ALMOST COMPLETED.—DOWN-STREAM FACE.

EAST BRANCH CROTON RESERVOIR, SODOM CENTER, N. Y.

THE DUNNING'S STEPPED MASONRY DAM, PENNSYLVANIA.

the maximum rate and continuance of rainfall can be approximated, or if the maximum high water marks reached by the stream before it was dammed can be found, then the maximum rate of discharge can be arrived at very closely, and the length of waste way determined. In a new country these data cannot be had, and the engineer must make such assumptions as seem to him safe. How dangerous it is to proceed without this knowledge is shown by the case of the Sweetwater dam, before described, where the flood of January, 1895, was ten times as great as the assumed maximum. In such cases it is necessary to so construct the dam as to allow the flood to flow over it for a short period in an emergency, without endangering it.

The wasteway is not simply the overflow weir, but the entire lateral



LATERAL CHANNEL, NEW CROTON DAM.

channel leading from this weir; and care must be taken to see that the capacity of this channel is always greater than that of the weir, so that the weir is the controlling or governing element. Such a properly-designed lateral channel is arranged for in the new Croton dam plans. This channel is stepped for the purpose of avoiding too high a velocity of water, on the one hand, and too great a vertical fall, on the other.

Sometimes the wastage can be across a dividing ridge into a neighboring drainage basin, and sometimes it is through tunnels in the solid rock around one or both sides of the dam. Waste gates and scouring sluices may also be placed in the body of the dam itself. Especially is this done in the case of irrigation dams and diversion

weirs. In the case of the lower Nile the flow is all passed through such sluices, the height to which the water is raised being only about 15 ft.

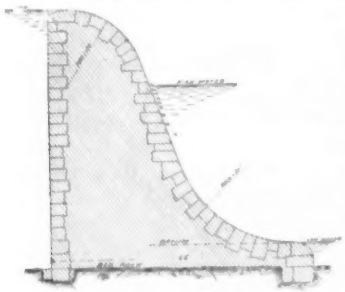


FIG. 5.—COLORADO RIVER DAM AT AUSTIN, TEXAS.

When the dam itself, in whole or in part, serves, as the waste weir, it must, of course, be built of masonry, and the weir and lower side must be built in the most substantial manner. It is customary to make these parts of large granite blocks, thoroughly bonded, and laid with best cement mortar with dressed joints. It is desirable, also, to make this lower side a plane of double curvature, as shown in Fig. 5, making the beds of the courses approximately normal to the surface at all points. This prevents any actual impact of the water against the surface, and discharges the flow horizontally from the outer toe of the dam. The masonry dam across the Mohawk river at Cohoes has recently been repaired by constructing a curved front of quarter-inch steel plates on a steel framework. These were backed by concrete. Many engineers prefer to make the lower face of an overflow dam a series of stone steps, thus destroying the acquired energy of the water at each step, and so preventing any violent action upon the masonry. For low overfalls this construction serves the purpose very well, as at the Dunning's dam, Pa.; but, for overfalls several feet in depth on the weir, these steps would have to be so very broad as to produce an extravagant width of profile.

While masonry and earthen dams are among the earliest kinds of engineering works, and while we have in this field as good a "hindsight" as in any other branch of engineering, yet the building of dams so as to insure security, economy, and permanency still demands the highest engineering ability. Our best engineers approach this problem with a feeling of grave responsibility, and they design and execute such works with the most conscientious and painstaking care and study. When so undertaken, and with a guarantee of sufficient means, these enterprises may be entered upon with a feeling of absolute certainty of permanent success, while in incompetent hands, or with insufficient funds, these structures are always liable to be a source of loss to their owners and of danger to the lives and property situated in the valleys below them.

THE VALUE OF GOOD ARCHITECTURE IN CITIES.

By Barr Ferree.

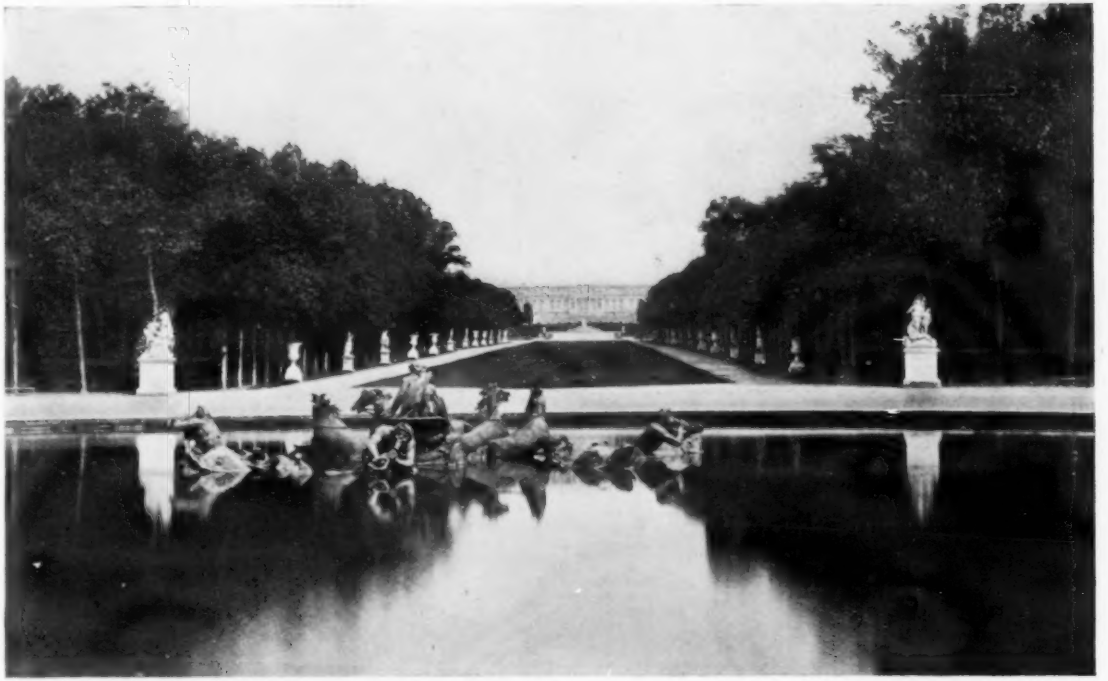
FROM the obelisk in the Place de la Concorde one sees spread out before him, not only the most magnificent spectacle in Paris, but one of the grandest sights in Europe. To the north, stretching in almost endless perspective, is the beautiful avenue of the Champs Élysées, heavily wooded on each side with trees, and closed in the far distance by the Arc de Triomphe. To the left are the stately buildings of the Garde Meuble, with the façade of the Madeleine at the end of the Rue Royale between them. Far off, on the other side of the Seine, is the porticoed front of the Chambre des Députés, with many other noble buildings on the river. To the south are the gardens of the Tuileries, and beyond is the vast court of the Louvre, whose sumptuous architecture and great extent make it one of the most monumental buildings in the world. There is everything in the view to fascinate the beholder, and even to overpower him with the sense of man's ability to create beauty out of the work of his hand. Every part of this tremendous spectacle, if we except the river Seine, has been made by man for his own delectation and delight. And there is the union here of everything that could contribute to the architectural grandeur of the scene. This Place de la Concorde, in which we imagine ourselves standing, is magnificent in itself, with fountains and statues, ornamental balustrades and lamp-posts. The parks on either side, though almost in the heart of Paris, are of great extent, not only allowing ample scope for artistic treatment, but large enough to give each of the buildings around them a distinct individuality. And each is a masterpiece, each a work of art that we count, and always shall count, among the great achievements of architecture.

Paris is full of monumental buildings and artistically-planned spaces, though nowhere is the effect so surpassingly grand as between the Louvre and the Arc de Triomphe. The Opéra, the Palais Royal, the cathedral church of Notre Dame, the Palais du Luxembourg, the Hôtel de Ville, the Palais de Justice, and many other public buildings in this superbly-built capital are veritable object lessons in art, instructors of the people, sources of genuine joy and satisfaction to those who see them, monuments with a civic and educational force apart from their purely architectural interest.

This is the real value of artistic architecture in cities, though as

HOTEL DE VILLE, PARIS.

THE COURT OF THE LOUVRE, PARIS.



IN THE GARDENS AT VERSAILLES.

yet we scarce understand it so in our American communities. It is true that, of the thousands of strangers who flock to Paris every year, only a relatively small portion go especially for its monuments. But these monuments, by their art, their splendor, and their number, help, in a very material way, to make Paris the world-capital it is; for Paris without its monuments would be, not Paris at all, but a commonplace town in which there was nothing to see and perhaps not much to do!

Paris is the most conspicuous instance of a monumental city, magnificently planned and filled with great works of architecture; but there is not a capital of Europe that has not an abundance of splendid

THE PIAZZA DI SAN PIETRO, ROME. FROM THE DOME OF ST. PETER'S.

buildings. Venice has its Piazza di San Marco; Florence and Pisa have their cathedral groups; Rome has its Piazza di San Pietro, Piazza del Campidoglio, and Piazza del Popolo; Vienna its Ring Strasse; Dresden its Zwinger; Berlin its Königsplatz; Munich its Königsplatz; Moscow its Kremlin; London its Houses of Parliament and Westminster Abbey. It would be easy to extend the list, for to be complete it must include all those great buildings that make a European tour not only delightful, but a liberal education in itself. These examples, however, must suffice as instances where a single great building, or a group of buildings, alone or in connection with surroundings, form an artistic centre in their respective cities, and in

OPERN & KÄRNTHNERRING, VIENNA.

ZWINGER GALLERIES, DRESDEN.

many instances rise to the height of the sublime, and in all teach impressive lessons of art and culture.

The education of the people is a problem that has confronted thinking men of all nations for centuries. That mankind has a natural tendency to sink, and that he must be dragged out of the depths towards which he naturally gravitates, appears to be an unquestioned sociological fact. Almost up to the present time the efforts of educators have been limited chiefly to mental discipline by books. But the tendency of education is rapidly changing. The introduction of technical schools for higher studies prepared the way for manual training for less advanced students. It has been borne in upon those who direct the educational systems of nations that there is an instruction by eye and by hand that may be as valuable as education by mind. And so art training has become an integral part of the common-school curriculum, though as yet it is not very well organized or properly systematized. But it has "arrived," as the French say, and, having come, it must bring with it permanent lessons of truth and beauty.

But modern life is too active for the art education of the people to be limited to that which they may gain within the confines of the school-room. It is not like the differential calculus, to be taken up at one brief period of existence and then cast aside forever save by specialists. The glory of art is its beauty and its permanency, which

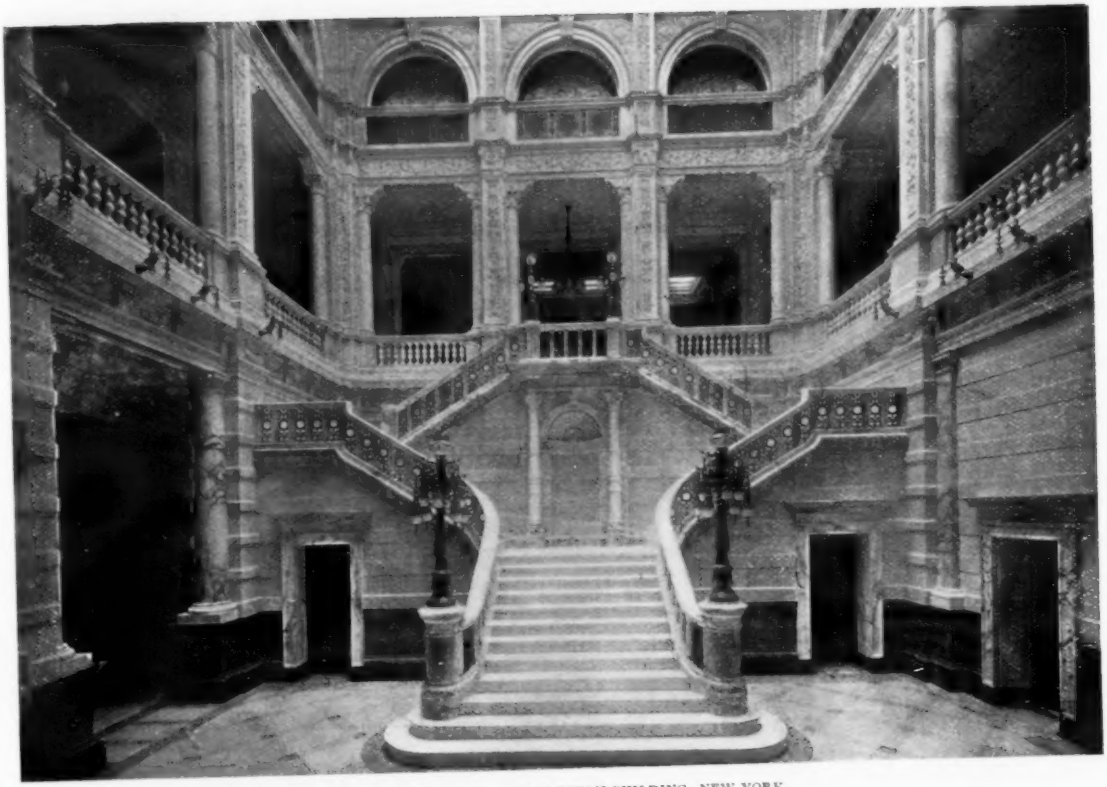
THE OLD PICTURE GALLERY AND BRIDGE, BERLIN.

lighten and brighten our lives at every moment; and the more abundantly we can surround the people with beautiful things, with fine parks and flowers, with magnificent buildings, with noble sculpture, yes, and cover our churches, our civic buildings, and the walls of our museums with inspiring pictures, the better it will be for our national welfare, the more firmly will our culture be strengthened, the broader will be our sympathies, the keener our appreciation of what is noble and good.

How much there is to be done in this direction every thoughtful American must be fully aware. Though our cities are numbered among the largest of the world; though our individual and national wealth surpasses that of any other country; though our national resources are boundless and our people renowned for a highly developed inventive faculty,—we have few monuments of art worthy of the name, few inspiring buildings that appeal to educated and uneducated eyes alike.

PLACE DE LA BOURSE, BORDEAUX.

Yet we can show some steps of progress. All our great cities have their parks and public gardens, in which each year brings a notable advance in landscape and floral art. And our wealthy men have cordially agreed upon the necessity for handsome residences for themselves in town and country, and ornamental architecture in this class of build-



INTERIOR COURT, METROPOLITAN BUILDING, NEW YORK.

ings has taken a good step forward. And we have done more than that; for our business corporations, great commercial companies, and large investors are spending vast sums of money in the erection of costly commercial buildings, hotels, and apartment houses in which an artistic effect is attempted, even though it be not always achieved.

This much we may credit ourselves with; yet how paltry and insignificant our achievements when compared with the splendid municipal art of Europe! True, the continental cities have the advantage of age over the American, but many notable buildings have been erected abroad in the same time that we have been taking our first wobbling footsteps in civic adornment. The transformation of modern Paris is sufficient answer to those who would plead the extreme youth and

METROPOLITAN CLUB, NEW YORK.

extraordinarily tender age of American communities as an excuse for their lack of artistic buildings.

Of our national architecture the less said the better. It exists, it is true, to the defoulment of our cities and the debasement of our national intelligence; and, though these buildings are of stone and brick, and therefore lasting, it is some satisfaction to know that the voice of

condemnation against them is swelling in volume each year. It is at least encouraging that the public at large feel there is "something the matter" with our government buildings, and recognize that here is a type of architecture to be shunned as we would shun a pestilential disease.

There is yet scarcely a hint of improvement in the buildings erected under the direction of our national government, and there certainly never will be while our government architecture is devised in the present extraordinary wholesale fashion; and those done by our municipal and State authorities are scarcely better. One of the latest buildings erected by the city of New York, the criminal court house, is quite as bad as anything turned out by the architectural mill of the treasury department at Washington. The two most costly public buildings in America, the capitol at Albany and the new public buildings in Philadelphia, have nothing to commend them but their cost and their size, and a certain gaudiness of interior decoration that cannot make up for the lack of real art. On the other hand some extremely beautiful small buildings for municipal use have been built in Boston by Mr. E. M. Wheelwright, and a few State governments, notably those of Rhode Island, Minnesota, and the State of Washington, have instituted architectural competitions for new capitols, which, although the system is a bad one, have resulted in designs that show a decided advance over the capitols of the average type.

These things, however, are scarce more than a drop in the vast well of architectural betterment that is needed in every American city, and very foolish and insignificant they are, compared with what may be seen abroad, both in the capitals and in the second- and third-rate cities that few take the trouble to visit. We have fine sites and costly structures, and our men of wealth do not stint expenditure on buildings for their own use; but the results are not always good in themselves or in their individual parts. Take, for example, City Hall park in New York, and the streets that surround it. Though the park is small, the buildings on Broadway and Park row are sufficiently distant from each other to escape the appearance of crowding. Neglecting the buildings in the park, and the horrible structure used by the national government as a post office and court house that shuts in one end, and neglecting, also, the older buildings still remaining, the sum of $10,000,000 would be a conservative estimate of the money expended in the last ten years upon the great buildings that now look down upon the little City Hall in the centre of the green. This is a considerable sum of money, and in the hands of the French government would have secured for the city in which it was spent at least one monumental building of a real artistic value, or a whole series of

structures of which each, we may be sure, would have been a true municipal ornament.

It is needless to say that we have none of this in the neighborhood of the City Hall Park. The new buildings are large and costly, but, with the exception of the Times and the Home Life buildings, both of which are open to criticism, there is not one that might not, with the utmost benefit to art, be swept off the face of the earth. Yet this very place, the heart of New York's municipal life, is the spot of spots that calls for careful and artistic treatment, and where fine buildings could not but have an ennobling effect upon the vast numbers of people who daily pass through it. It is little wonder, when one thinks of the abominable buildings that are shutting in this breathing place, that it is frequented by loafers and thugs. Were the surroundings of the splendor suited to the place, who can tell but that it might become "too stylish" or too refined for the People who now make it a place of common resort!

Much more happy in the buildings that surround it, though at the same time a conspicuous example of the difficulties under which the architecture of cities is improved in America, is the Plaza at the entrance to Central Park at Fifty-ninth street and Fifth avenue. This is scarce more than the junction of two streets, but the open park on one corner and a little open area within the space of junction give an airiness and spaciousness to it that are quite unusual for so limited a spot. Architecturally, this is the most monumental quarter in New York, though it will speedily be exceeded, in this respect, by the new buildings on the upper west side, which will include the cathedral of St. John the Divine, Columbia College, and St. Luke's Hospital.

Yet everything here has been done by private enterprise, and at various periods. On one side is the vast red brick and terra cotta bulk of the Plaza Hotel,—not a notable structure in itself, but, like the larger Savoy Hotel opposite, devoid of any marked unpleasantness of design. On the lower side is the palace built by Mr. Vanderbilt,—a picturesque pile that is the most spacious private city residence in America. Opposite the Plaza Hotel is an apartment house, the Savoy Hotel, and the ungainly but striking Netherlands Hotel. Beyond is the beautitul house of the Metropolitan Club, with Mr. Gerry's residence next to it.

If we close our eyes to many deficiencies in detail and in composition of most of the structures in this group, it must be admitted that the general effect is fine. The buildings are large and have a certain air of splendor that properly accompanies liberal expenditure. Their greatest misfortune is that there is no balancing of parts, and none of that relationship which should exist between the members of a group

THE SCHILLER THEATRE, CHICAGO.

such as these buildings form. Not that, on a place like this, we should necessarily have symmetrical buildings, once so popular in Europe, and of which the Place Vendome in Paris and the Place de la Bourse in Bordeaux are striking examples, more successful than the many places, crescents, and circusses of London. We do not need a cold formalism in our architecture, or a duplication of designs, for a good effect around an open space; but certainly the result would

have been happier, had the designs of the different buildings been conceived from the point of view of an *ensemble*, instead of singly and separately, regardless of relationship.

Of all the buildings that compose this group the most notable is the house of the Metropolitan Club. It is the one building that speaks for art alone, and which has a monumental value that the more utilitarian structures near it cannot have. It strikes a new note in the picture, a note of art and of beauty, of refinement, of purity of line, of fine proportions, of skilful workmanship, of noble purpose. I should be loath to characterize this building as the finest structure in New York, but I am confident I shall not be misunderstood when I say that I know no other public or semi-public building that is as great an ornament to the metropolis as this, or one that can teach so direct and simple a lesson of the value of art—a lesson which is all the more pointed because of the proximity of other great buildings less happily designed.

This is a conspicuous instance of the way in which our wealthy men are beautifying our American cities, though in every case they first consider their own pleasure. There are many others. We now have scarce a city in which there is not a series of private residences whose artistic beauty makes them real landmarks in the wilderness of mediocrity once seemingly so popular. Compare Seventy-second street in New York, for example, with some of the newer streets on the upper west side. The former is one of the most distressing thoroughfares in the world, lined with dwellings whose average commonplaceness is something astonishing, and beside which the featureless buildings along the Rue de Rivoli in Paris, such as the Magasins du Louvre, the Hotel Continental, and the like, have a quiet restfulness that is almost beautiful. In the newer districts of New York are many examples of the work of the individual architect who loves his task and designs with a serene consciousness of artistic ability. Nor is the new movement confined to one city. Philadelphia, that architectural nightmare which has become a byword among nations, has now, thanks to a small company of architects, among whom Mr. Wilson Eyre, Jr., and Mr. Frank Miles Day are the most conspicuous, many notable private dwellings that in artistic feelings and design are among the most interesting yet built in this country.

And so in other cities. In Washington, Boston, Chicago, St. Louis, Denver, and Minneapolis, friendly eyes will find much to praise, much to rejoice at, as indicative of good times for art, not coming, but already arrived. In some of these it will be the semi-suburban house that will prove the most attractive and offer the best illustration of artistic workmanship. In Chicago it is the business buildings, like the Auditorium, the Schiller theatre, the Monadnock Block, the Stock

Exchange, the Old Colony Building, and others, that command attention by reason of their artistic treatment and the comparison they offer with more ornate and less logically designed structures in the east.

The formation of Municipal Art Societies, in New York, Philadelphia, Boston, and Chicago, in the last year or two, is another notable sign of the progress of municipal art. True, some of these societies have in view only the encouragement of painting and decorating public buildings; but others include a broader view, and hope, in time, to influence architecture and the general aspect of our cities.

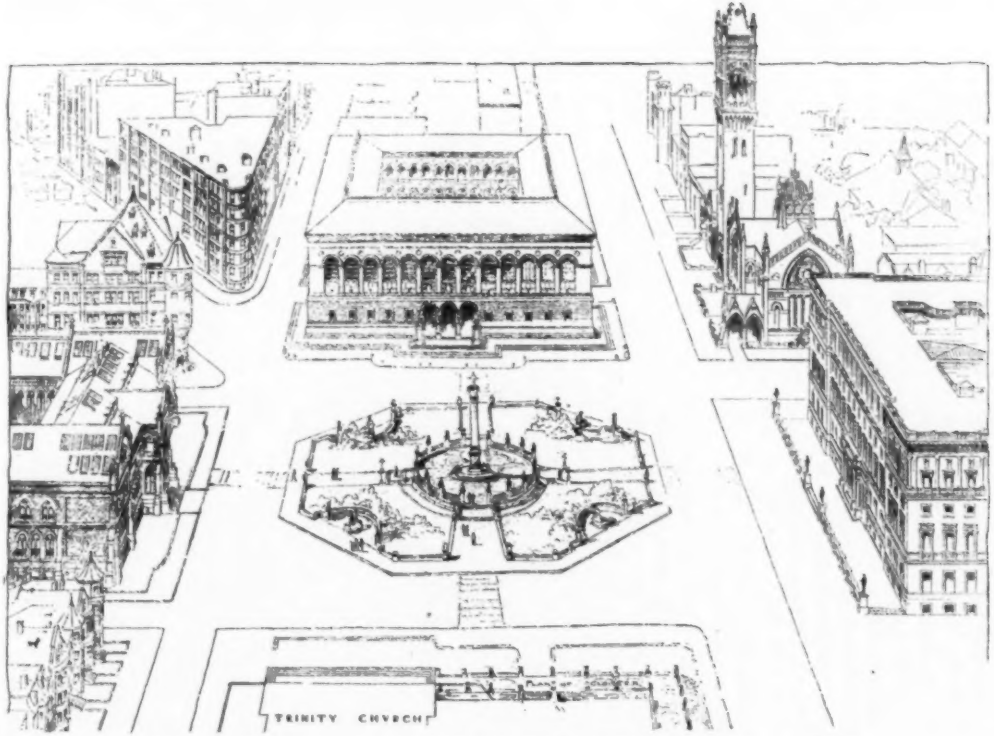
All of this means a good deal. It means more than architectural progress; more than a broadening of architectural appreciation; more than a simple wish to own the handsomest house or the most costly office-building. It means a real growth in artistic sentiment, and the opening up of a new source of educative influence to the people. It is good to walk through a street lined with artistic buildings; or, in a ramble in the country, to come upon a house that attracts by its beauty and the art of its surroundings; or to wander through the palatial courts and corridors of a Ponce de Leon. It is good to have art in the design of the house as well as within its walls; to spread it forth in our business buildings as well—let us hope that time will come—as upon our civic structures. A good building is like a good thought,—pure, elevating, ennobling. We can live in an ugly house and transact business in a monstrosity; but surely it is an added joy in life to have our houses fine and beautiful, and our commercial buildings spacious and monumental. Compared with what other people have had to work with, our opportunities are small and our difficulties great. Yet even within our narrow limits a good deal has been accomplished, and, with the spread of architectural appreciation that must inevitably come with time, much more will be done. But we must realize our limitations, and then, instead of deploring our lot, set to work to do the best we can within them. When a great business corporation, like the Metropolitan Life Insurance Company, will spend a very large sum in erecting a monumental court in their chief office building in New York, a court designed with fine artistic skill, set off with rich marble and onyx and bronze, to be completed, in time, with paintings on the enclosing walls,—when a business corporation carries out so notable a work as this, without utility in its costliness or necessary structural value, but purely as a work of art to delight the eye, then surely a new spirit of beauty has come upon our architecture that cannot but give to it an ethical value it cannot have when purely utilitarian.

Good architecture, fine architecture, monumental architecture, have a distinct value to the community in which they are found. As wealth attracts wealth, so beauty brings beauty. It is not, indeed,

pleasant to think that Mr. A. has built a superb house only because Mr. B.'s new mansion was more imposing than the house Mr. A. had been living in. Yet this rivalry is a healthful one and old. Each medieval bishop wanted a finer cathedral than his brother bishop had, and forthwith churches were pulled down and new ones erected that are still the marvel of every beholder. Each Italian prince, and each great nobleman of France, must needs have a new palace or a fresh château finer than any other, when the architects of the Renaissance had showed how to build them in the new style. A great gulf of art as well as of time separates us from these doings, but this ancient spirit has not yet been extinguished; and, though we operate on a smaller scale, we are doing the very sort of thing that produced the world's greatest monuments of art. It is true that some commercial corporations still imagine, with that soullessness for which corporations are proverbial, that height and size and cost are the proper measures to be applied to excellence in architecture. But the later building, though it be larger and higher and more costly than any of its predecessors, will show an artistic advance that is not the less significant because associated with unartistic conditions.

Much that has been done in the way of good architecture in this country has had its origin in motives that may be termed personal or selfish, and without regard to the effect upon what others have done. The men who built the palaces of Newport did so because it was congenial to their tastes to live in sumptuous dwellings. But these imposing villas and mansions have a value to the community of Newport, and to the many visitors to that famous watering-place, that is quite distinct from the satisfaction they give their owners. Still, though the larger part of our civic adornment has been done in this purely personal way, we can count some monuments—few and far between, perhaps—which, at the outset, were intended to have, and which do have, a direct influence upon the public. The Metropolitan Club and the Washington Arch are examples of this proper public spirit in New York. Boston has its beautiful Public Library—one building in a group surrounding Copley square which, taken all in all, is perhaps the most successful monumental group in America. Chicago has its Art Institute and its Newberry Library, and a few other buildings throughout the country testify to the same spirit. Truly, if it is well to adorn our cities with such noble buildings as these, will it not be better to add to their quantity and their quality with each new undertaking?

The beginnings of such a movement have already taken root among us, not in one community, but in many; and, as time speeds on, it must gather strength and spread, adding to the attractiveness of our



SCHEME FOR THE DECORATIVE TREATMENT OF COPLEY SQUARE, BOSTON. BY W. G. PRESTON.

cities and lightening the dreary lives of the people within them, who know no beauty but that which they see upon the streets. We may be thankful for what has been accomplished; but much must be done before we can look with satisfaction upon the artistic aspects of American cities.

And has good architecture an elevating and educational effect upon the people? The question scarcely needs to be propounded. Many a time I have seen the workingmen and peasants in France gazing earnestly at the fine buildings that make that country a veritable treasure-house of art. It needs no argument to insist on the utility of such structures, for, though an uneducated person will not derive from them that joy and satisfaction that is natural to the trained mind, a noble building can not be seen without producing at least some effect of good. In our own country the value of good architecture is not so much appreciated as abroad; else the appearance of our cities would be less open to criticism. Our people gaze with wonderment upon the palaces of Mr. Vanderbilt and Mr. Astor, at the Metropolitan Club, or at the vastness of the building of the American Surety Company. It is doubtless true that it is not the art of these buildings that attracts, so much as their size and cost and the fact that they belong to well-known people. Grant that, if you will; still does not the greater fact remain that it is better they should have an art quality than none at all, and that at least some memory of their beauty will be taken away?

Have you ever watched the people who stop to gaze at the contents of the windows of the art shops, or who crowd the art museums on a Sunday or a holiday? What matters it if the comments are ill-judged or thoughtless; it is enough that people look at beautiful things and enjoy them, even in a homely and commonplace way. If beauty is present, a constant looking at it must produce a good effect. So with architecture. A good building is as easy to build as a bad one, and costs no more. All such structures have an art value for the people which is not to be measured in money, and which must, in time, influence our national life and thought as the beautiful buildings of Europe do in those communities of which they have so long been the chief ornament.

A PIECE-RATE SYSTEM AND SHOP MANAGEMENT.*

By Fred. W. Taylor.

THE ordinary piece-work system involves a permanent antagonism between employers and men, and a certainty of punishment for each workman who reaches a high rate of efficiency. The demoralizing effect of this system is most serious. Under it even the best workmen are forced continually to act the part of hypocrites, to hold their own in the struggle against the encroachments of their employers.

The system introduced by the writer, however, is directly the opposite, both in theory and in its results. It makes each workman's interest the same as that of his employer, pays a premium for high efficiency, and soon convinces each man that it is for his permanent advantage to turn out each day the best quality and maximum quantity of work. The system consists of three principal elements:

(1) An elementary rate-fixing department.

(2) The differential-rate system of piece-work.

(3) What he believes to be the best method of managing men who work by the day.

Elementary rate fixing differs from other methods of making piece-work prices in that a careful study is made of the time required to do each of the many elementary operations into which the manufacturing of an establishment may be analyzed or divided. These elementary operations are then classified, recorded, and indexed, and, when a piece-work price is wanted for work, the job is first divided into its elementary operations, the time required to do each elementary operation is found from the records, and the total time for the job is summed up from these data.

The differential-rate system of piece-work consists, briefly, in offering two different rates for the same job; a high price per piece, in case the work is finished in the shortest possible time and in perfect condition, and a low price, if it takes a longer time to do the job, or if there are any imperfections in the work. (The high rate should be

* The paper here presented in abstract was read by Mr. Taylor at the Detroit meeting of the American Society of Mechanical Engineers in June, 1895. At that time it attracted much attention and favorable comment. We regard it as one of the most valuable contributions that have ever been given to technical literature, and by reason of that fact, together with the revival of manufacturing activity which has set in, we deem it eminently fitting to accord the paper that distinction which its importance and originality unquestionably merit.—THE EDITOR.

such that the workmen can earn more per day than is usually paid in similar establishments.) This is directly the opposite of the ordinary plan of piece-work, in which the wages of the workmen are reduced when they increase their productivity.

The system by which the writer proposes managing the men who are on day-work consists in paying *men* and not *positions*. Each man's wages, as far as possible, are fixed according to the skill and energy with which he performs his work, and not according to the position which he fills. Every endeavor is made to stimulate each man's personal ambition. This involves keeping systematic and careful records of the performance of each man, as to his punctuality, attendance, integrity, rapidity, skill, and accuracy, and a readjustment from time to time of the wages paid him, in accordance with this record.

The advantages of this system of management are:

First. That the manufactures are produced cheaper under it, while at the same time the workmen earn higher wages than are usually paid.

Second. Since the rate-fixing is done from accurate knowledge, instead of more or less by guess-work, the motive for holding back on work, or "soldiering," and endeavoring to deceive the employers as to the time required to do work, is entirely removed, and with it the greatest cause for hard feelings and war between the management and the men.

Third. Since the basis from which piece-work as well as day rates is fixed is that of exact observation, instead of being founded upon accident or deception, as is too frequently the case under ordinary systems, the men are treated with greater uniformity and justice, and respond by doing more and better work.

Fourth. It is for the common interest of both the management and the men to coöperate in every way, so as to turn out each day the maximum quantity and best quality of work.

Fifth. The system is rapid, while other systems are slow, in attaining the maximum productivity of each machine and man; and, when this maximum is once reached, it is automatically maintained by the differential rate.

Sixth. It automatically selects and attracts the best men for each class of work, and it develops many first-class men who would otherwise remain slow or inaccurate, while at the same time it discourages and sifts out men who are incurably lazy or inferior.

Finally. One of the chief advantages derived from the above effects of the system is that it promotes a most friendly feeling between the men and their employers, and so renders labor unions and strikes unnecessary. There has never been a strike under the differen-

tial-rate system of piece-work, although it has been in operation for the past ten years in the steel business, which has been during this period more subject to strikes and labor troubles than almost any other industry.

The theory upon which the ordinary system of piece-work operates to the benefit of the manufacturer is exceedingly simple. Each workman, with a definite price for each job before him, contrives a way of doing it in a shorter time, either by working harder or by improving his method; and he thus makes a larger profit. After the job has been repeated a number of times at the more rapid rate, the manufacturer thinks that he should also begin to share in the gain, and therefore reduces the price of the job to a figure at which the workman, although working harder, earns, perhaps, but little more than he originally did when on day work. The actual working of the system, however, is far different. Even the most stupid man, after receiving two or three piece-work "cuts," as a reward for having worked harder, resents this treatment, and seeks a remedy for it in the future. Thus begins a war —generally an amicable war, but none the less a war—between the workmen and the management. The latter endeavors by every means to induce the workmen to increase the output, and the men gage the rapidity with which they work so as never to earn over a certain rate of wages, knowing that, if they exceed this amount, the piece-work price will surely be cut, sooner or later.

But the war is by no means restricted to piece-work. Every intelligent workman realizes the importance, to his own interest, of starting in on each new job as slowly as possible. There are few foremen or superintendents who have anything but a general idea as to how long it should take to do a piece of work that is new to them. Therefore, before fixing a piece-work price, they prefer to have the job done for the first time by the day. They watch the progress of the work as closely as their other duties will permit, and make up their minds how quickly it can be done. It becomes the workman's interest then to go just as slowly as possible, and still convince his foreman that he is working well. The effect of this system of piece-work on the character of the men is, in many cases, so serious as to make it doubtful whether, on the whole, well-managed day-work is not preferable.

There are several modifications of the ordinary method of piece-work which tend to lessen the evils of the system, but I know of none that can eradicate the fundamental causes for war, and enable the managers and the men to heartily coöperate in obtaining the maximum product from the establishment. It is the writer's opinion, however, that the differential-rate system of piece-work in most cases entirely harmonizes the interests of both parties.

Coöperative experiments have failed, and, I think, are generally destined to fail, for several reasons, the first and most important of which is that no form of coöperation has yet been devised in which each individual is allowed free scope for his personal ambition. This always has been and will remain a more powerful incentive to exertion than a desire for the general welfare. The few misplaced drones, who do the loafing and share equally in the profits with the rest, under co-operation are sure to drag the better men down toward their level. The second and almost equally strong reason for failure lies in the remoteness of the reward. The average workman (I don't say all men) cannot look forward to a profit which is six months or a year away. Other and formidable difficulties in the path of coöperation are the equitable division of the profits, and the fact that, while workmen are always ready to share the profits, they are neither able nor willing to share the losses. Further than this, in many cases, it is neither right nor just that they should share either in the profits or the losses, since these may be due in great part to causes entirely beyond their influence or control, and to which they do not contribute.

When we recognize the real antagonism that exists between the interests of the men and their employers under all of the systems of piece-work in common use; and when we remember the apparently irreconcilable conflict implied in the fundamental and perfectly legitimate aims of the two: namely, on the part of the men, *the universal desire to receive the largest possible wages for their time;* and on the part of the employers, *the desire to receive the largest possible return for the wages paid,*—what wonder that most of us arrive at the conclusion that no system of piece-work can be devised which shall enable the two to coöperate without antagonism and to their mutual benefit? Yet it is the opinion of the writer that, even if a system has not already been found which harmonizes the interests of the two, still the basis for harmonious coöperation lies in the two following facts:

First. That the workmen in nearly every trade can and will materially increase their present output per day, providing they are assured of a permanent and larger return for their time than they have heretofore received.

Second. That the employers can well afford to pay higher wages per piece, even permanently, providing each man and machine in the establishment turns out a proportionately larger amount of work. The truth of the latter statement arises from the well-recognized fact that, in most lines of manufacture, the indirect expenses equal or exceed the wages paid directly to the workmen, and that these expenses remain approximately constant, whether the output of the establishment is great or small. From this it follows that it is always cheaper to pay

higher wages to the workmen when the output is proportionately increased, the diminution in the indirect portion of the cost per piece being greater than the increase in wages. Many manufacturers, in considering the cost of production, fail to realize the effect that the volume of output has on the cost. They lose sight of the fact that taxes, insurance, depreciation, rent, interest, salaries, office expenses, miscellaneous labor, sales expenses, and frequently the cost of power (which in the aggregate amount to as much as wages paid to workmen) remain about the same, whether the output isgreat or small.

In our endeavor to solve the piece-work problem by the application of the two fundamental facts above referred to, let us consider the obstacles in the path of harmonious coöperation, and suggest a method for their removal. The most formidable obstacle is the lack of knowledge on the part of both the men and the management (but chiefly the latter) of the quickest time in which each piece of work can be done; or, briefly, the lack of accurate time-tables for the work of the place. The remedy for this trouble lies in the establishment in every factory of a proper rate-fixing department,—a department which shall have equal dignity and command equal respect with the engineering and managing departments, and which shall be organized and conducted in an equally scientific and practical manner.

The elementary system of fixing rates has been in successful operation for the past ten years, on work complicated in its nature, and covering almost as wide a range of variety as any manufacturing that the writer knows of. In 1883, while foreman of the machine shop of the Midvale Steel Company of Philadelphia, it occurred to the writer that it was simpler to time each of the elements of the various kinds of work done in the place, and then find the quickest time in which each job could be done by summing up the total times of its component parts, than it was to search through the records of former jobs, and guess at the proper price. After practising this method of rate-fixing himself for about a year, as well as circumstances would permit, it became evident that the system was a success. The writer then established the rate-fixing department, which has given out piece-work prices in the place ever since. This department far more than paid for itself from the very start; but it was several years before the full benefits of the system were felt, owing to the fact that the best methods of making and recording time-observations of work done by the men, as well as of determining the maximum capacity of each of the machines in the place, and of making working-tables and time-tables, were not at first adopted.

A man whose business it is to fix rates soon becomes so familiar with the time required to do each kind of elementary work performed

by the men that he can write down the time from memory. In the case of that part of the work which is done by the machine, the rate-fixer refers to tables which are made out for each machine.

While, however, the accurate knowledge of the quickest time in which work can be done, obtained by the rate-fixing department and accepted by the men as standard, is the greatest and most important step towards obtaining the maximum output of the establishment, it is one thing to know how much work can be done in a day, and an entirely different matter to get even the best men to work at their fastest speed or anywhere near it.

Whether coöperation, the differential plan, or some other form of piece-work be chosen, in connection with elementary rate-fixing, as the best method of working, there are certain fundamental facts and principles which must be recognized and incorporated in any system of management, before true and lasting success can be obtained; and most of these facts and principles will be found to be not far removed from what the strictest moralists would call justice. The most important of these facts is that *men will not do an extraordinary day's work for an ordinary day's pay;* and any attempt on the part of employers to get the best work out of their men and give them the standard wages paid by their neighbors will surely be, and ought to be, doomed to failure.

Justice, however, not only demands for the workman an increased reward for a large day's work, but should compel him to suffer an appropriate loss, in case his work falls off either in quantity or quality. It is quite as important that the deductions for bad work should be just, and graded in proportion to the shortcomings of the workman, as that the reward should be proportional to the work done. The fear of being discharged, which is practically the only penalty applied in many establishments, is entirely inadequate to producing the best quantity and quality of work; since the workmen find that they can take many liberties before the management makes up its mind to apply this extreme penalty.

It is clear that the differential rate satisfies automatically, as it were, the above conditions of properly-graded rewards and deductions. Whenever a workman works for a day (or even a shorter period) at his maximum, he receives under this system unusually high wages; but, when he falls off either in quantity or quality from the highest rate of efficiency, his pay falls below even the ordinary. The lower differential rate should be fixed at a figure which will allow the workman to earn scarcely an ordinary day's pay when he falls off from his maximum pace, so as to give him every inducement to work hard and well. The exact percentage beyond the usual standard which

must be paid to induce men to work to their maximum varies with different trades and with different sections of the country.

It is not, however, sufficient that each workman's ambition should be aroused by the prospect of larger pay at the end of even a comparatively short period of time. The stimulus to maximum exertion should be a daily one. This involves such vigorous and rapid inspection and returns as to enable each workman in most cases to know each day the exact result of his previous day's work,—*i. e.*, whether he has succeeded in earning his maximum pay, and exactly what his losses are for careless or defective work. Two-thirds of the moral effect, either of a reward or penalty, is lost by even a short postponement. And it is equally important for the management to know whether the work has been properly done.

As far as possible, each man's work should be inspected and measured separately, and his pay and losses should depend upon his individual efforts alone. It is, of course, a necessity that much of the work of manufacturing—such, for instance, as running roll-trains, hammers, or paper machines—should be done by gangs of men who coöperate to turn out a common product, and that each gang of men should be paid a definite price for the work turned out, just as if they were a single man. In the distribution of the earnings of a gang among its members, the percentage which each man receives should, however, depend not only upon the kind of work which each man performs, but upon the accuracy and energy with which he fills his position. In this way the personal ambition of each of a gang of men may be given its proper scope. Again, we find the differential rate acting as a most powerful lever to force each man in a gang of workmen to do his best; since if, through the carelessness or laziness of any one man, the gang fails to earn its high rate, the drone will surely be obliged by his companions to do his best the next time or else get out.

A great advantage of the differential-rate system is that it quickly drives away all inferior workmen, and attracts the men best suited to the class of work to which it is applied; since none but really good men can work fast enough and accurately enough to earn the high rate, and the low rate should be made so small as to be unattractive even to an inferior man. If for no other reason than that it secures to an establishment a quick and active set of workmen, the differential rate is a valuable aid, since men are largely creatures of habit; and if the piece-workers of a place are forced to move quickly and work hard, the day-workers soon get into the same way, and the whole shop takes on a more rapid pace.

The greatest advantage, however, of the differential rate for piece-

work, in connection with a proper rate-fixing department, is that together they produce the proper mental attitude on the part of the men and the management toward each other. In place of the indolence and indifference which characterize the workmen of many day-work establishments, and to a considerable extent also their employers; and in place of the constant watchfulness, suspicion, and even antagonism with which too frequently the men and the management regard each other, under the ordinary piece-work plan,—both sides soon appreciate the fact that with the differential rate it is their common interest to coöperate to the fullest extent, and to devote every energy to turning out daily the largest possible output. This common interest quickly replaces antagonism, and establishes a most friendly feeling.

Of the two devices for increasing the output of a shop, the differential rate and the scientific rate-fixing department, the latter is by far the more important. The differential rate is invaluable at the start, as a means of convincing men that the management is in earnest in its intention of paying a premium for hard work, and it at all times furnishes the best means of maintaining the top notch of production; but, when, through its application, the men and the management have come to appreciate the mutual benefit of harmonious coöperation and respect for each other's rights, it ceases to be an absolute necessity. On the other hand, the rate-fixing department, for an establishment doing a large variety of work, becomes absolutely indispensable. The longer it is in operation, the more necessary it becomes.

The term "rate-fixing department" has rather a formidable sound. In fact, however, that department should consist, in most establishments, of one man, who, in many cases, need give only a part of his time to the work.

When the manufacturing operations are uniform in character, and repeat themselves day after day,—as, for instance, in paper or pulp mills,—the whole work of the place can be put upon piece-work in a comparatively short time; and, when once proper rates are fixed, the rate-fixing department can be dispensed with, at any rate until some new line of manufacture is taken up.

The system of differential rates was first applied by the writer to a part of the work in the machine shop of the Midvale Steel Company, in 1884. Its effect in increasing and then maintaining the output of each machine to which it was applied was almost immediate, and so remarkable that it soon came into high favor with both the men and the management. It was gradually applied to a great part of the work of the establishment, with the result, in combination with the rate-fixing department, of doubling, and in many cases trebling, the output, and at the same time increasing, instead of diminishing, the accuracy

of the work. In some cases it was applied by the rate-fixing department without an elementary analysis of the time required to do the work; simply offering a higher price per piece providing the maximum output before attained was increased to a given extent. Even this system met with success, although it is by no means correct, since there is no certainty that the reward is in just proportion to the efforts of the workmen.

In cases where large and expensive machines are used, such as paper machines, steam hammers, or rolling mills, in which a large output is dependent upon the severe manual labor as well as the skill of the workmen (while the chief cost of production lies in the expense of running the machines rather than in the wages pajd), it has been found of great advantage to establish two or three differential rates, offering a higher and higher price per piece or per ton as the maximum possible output is approached.

The rate-fixing department has shown the necessity of carefully systematizing all of the small details in the running of each shop; such as the care of belting, the proper shape for cutting tools, oiling machines, issuing orders for work, obtaining accurate labor and material returns, and a host of other minor methods and processes. These details, which are usually regarded as of comparatively small importance, and many of which are left to the individual judgment of the foreman and workmen, are shown by the rate-fixing department to be of paramount importance in obtaining the maximum output, and to require the most careful and systematic study and attention in order to insure uniformity and a fair and equal chance for each workman Without this preliminary study and systematizing of details, it is impossible to apply successfully the differential rate in most establishments.

The following table, from results in actual practice, will show the economy of paying high wages under the differential rate, as compared with the ordinary piece-work system. The work consisted in turning certain forgings.

COST OF PRODUCTION PER LATHE PER DAY.

Ordinary system of piece-work.		*Differential-rate system.*	
Man's wages	$2.50	Man's wages	$3.50
Machine cost	3.37	Machine cost	3.37
Total cost per day	$5.87	Total cost per day	$6.87
5 pieces produced.		10 pieces produced.	
Cost per piece	$1.17	Cost per piece	$0.69

This result was mostly, though not entirely, due to the differential rate. The superior system of managing all of the small details of the shop counted for considerable.

THE LAW OF WATER, AND MODERN IRRIGATION.

By Richard J. Hinton.

ON the 22d of July, 1895, United States Circuit Judge E. M. Ross delivered at Los Angeles a decision of momentous importance to all irrigation interests. The case before him was that of Maria K. Bradley *vs.* the Fallbrook irrigation district, San Diego Co., Cal., being a suit in equity by which it was sought to enjoin the execution of a deed for forty-one acres of land owned by Mrs. Bradley, under a sale by the collector of the Fallbrook irrigation district to satisfy a delinquent assessment held against property under the district act. The complainant alleged that this was not in accordance with the provisions of the constitution of the State, and that it conflicted with the federal constitution, as it attempts to deprive an individual of property without due process of law, and also takes private property for the use of a private corporation.

The judge sustained the allegations, and declared the irrigation district laws to be in conflict with the federal constitution. He further declared that the use for which said property is authorized by the State laws to be taken "is not a public use;" therefore such taking, use, taxation, and delinquent sales are infringements of the guaranteed rights of citizens.

Every question raised in the Bradley suit has been argued before, and decided the other way by the State supreme court, on appeals from superior courts. Some twenty judges of the higher court, and as many more of other State courts, have since 1888 affirmed the constitutionality of each issue now negatively decided by Judge Ross. The latter declares that the issues of uses involved are like those of commercial character, not to be wholly decided by State supreme courts, and that the legislative action declaring such use of water to be a public one cannot lawfully make it so. The character of use is not to be tested by the number of users merely, for the fact that all are not allowed to use is a measure adverse to public service and character. Property owners cannot be constrained to such class use, even though the general public may be more benefited by it than by their own use of lands. "It is extremely plain," declares the federal judge, "that the legislative purpose . . . . cannot be indicated in the plea that it directly conduces to the general welfare of the community." But, following this, he declared that taxation for drainage purposes of over-

flowed lands (tule) is a public use, because it largely "increases production." Such increase in California, through irrigation reclamation, is a hundred per cent. greater according to areas than all the results of reclamation drainage. But for the building up of great commonwealths, whose prosperity and security depend almost wholly upon such water service, Judge Ross can only say: "I can see no rational ground for the assumption that the schemes to be executed by this act are, in the main, matters which in any just sense can be said to be of public concern."

There is abundant testimony to the effect that one ordinary acre of irrigated land under cultivation will produce as much as three equivalent acres in the United States. France supports in comfort one person per acre. In this country it takes at least three acres to support a single person. On either estimate the enormous importance of western irrigation to the United States may be easily comprehended, since the population that could be supported on our arid lands under irrigation would be not less than thirty-three million and might reach one hundred million. The jurisprudence, then, that must largely shape such great possibilities is certainly a matter of high significance.

From the dawn of history agriculture appears to have begun in arid regions, or in those where enormous evaporation under tropical heat compels artificial water storage and distribution. Ancient civilizations of the most imposing proportions have been borne, economically speaking, upon this form of industry. At the present day one-third of the world's population raise their food supplies by the aid of irrigation. On this continent alone fifteen millions are largely dependent thereon, and the range increases. What, then, is the controlling principle called the law of water? It may be thus summarized:

No property character, and non ownership, public or private; a public trust, to be used for beneficial purposes only; accessibility by all to what is a natural element, essential to life and necessary for industry. These are primal and controlling principles. They cannot be overthrown, and must be followed, if peace be maintained, wherever arid conditions exist. Water possesses no characteristic of property, for it may not be found in place and cannot be identified. Being a natural element, if subjected to usufructuary conditions, it becomes a trust regulated by the sovereignty, and must be held for the common good. This is the rule of the Chinese irrigators with their petty water-wheels and bamboo pipes. It is the law of the great Anglo-Indian works, and the custom of the millions of Hindoo ryots who use water from shallow wells. It is the habit of the nomadic shepherds of Central Asia, and of the Egyptian fellahs who live by the Nile. Everywhere the principle at the back of all use and supervision in Italy,

Spain, France, or elsewhere—whether appliances are rude or scientific—is that of public control. The State may not dispose of it, but it must administer it for beneficial use alone. Even we are doing this, and have been for forty years, under the somewhat clumsy device called "prior appropriation." The result of use may become both personal and profitable; the thing used cannot be considered the one or made into the other. So the State cannot surrender; the individual may not control. The cost of use and the means of storage, conveyance, and distribution, involves payment therefor. In this way the enterprise of man finds a legal and legitimate return.

Judge Ross has, as has been already stated, adversely decided the question of the constitutionality of the State laws under which municipal districts have been formed to appropriate water, construct and own works, to irrigate lands from a common source under public direction, and permit the use of interest-bearing bonds with incidence of taxation for their payment. Necessarily, taxation carries with it the power of enforcement, and the sale of lands when owners are delinquent. Over thirty districts, large and small, have been organized. Bonds to the amount of about forty million dollars have been voted, and over half of these are negotiated. The opposition to the "Wright laws," as the statutes are termed, arises almost entirely from the possessors of large tracts of unused land and other influences at the back of them. It being found impracticable to destroy the law of water, the effort has been unremittent for its nullification: first, upon the plea that such use of water is not a public one; second, that the State has no power to create such a municipal corporation as an irrigation district; and, third, that it is an infringement of guaranteed rights to take property for the "private benefit" of others. All these questions have been systematically raised since 1887, in the State courts. The Wright laws require judicial confirmation of proceedings under them. In the course of such action, the issues have been uniformly settled in favor of the laws and upon the direct ground of public good. The State supreme court has, on appeal, rendered a score of such decisions. The federal judge ignores all this. He made caustic criticisms upon the laws in detail. These, however, are amendable by legislation, and his criticism could not permanently sustain destruction. What Judge Ross declares is that irrigation is a matter of private business and profit, not so public in character as to make constitutional the power of condemnation, the application of eminent domain, or sale for delinquent taxes. Upon the first and the last dicta, he would destroy the most important industry in California. The effect will be disastrous to all the arid region. The district system, in whole or part, is now operative in Washington, Oregon, Nebraska, Kansas, and the two Dakotas. It

has been provided for in Idaho also, while in all these States, and in Nevada, Montana, Colorado, Utah, and Wyoming, the constitutions under which they have been admitted into the Union, and the laws also, provide for State control, beneficial use, prior appropriation, public record, control of works, and regulation of rates for storage or ditch conveyance. The whole burden and purpose of State jurisprudence are in vigorous antagonism to the decision of Judge Ross in the case of certain persons versus the District of Fallbrook, San Diego, which is now on the appellate calendar of the United States supreme court. The State of California has joined with the district in the appeal from the circuit court. Judge Ross bases his declaration of unconstitutionality of irrigation laws taxing lands and then selling them for delinquency, upon the fourteenth amendment,—an instrument made to protect the public and personal rights of a race that had been held as slaves. Whether the federal judge meant it or not, the result is, so far as his decision goes, to nullify the treaty of Guadaloupe-Hidalgo, to override the law of appropriation, to do that which the federal judiciary systematically avoids doing whenever possible,—*i. e.*, take action counter to the decision of State supreme courts,—and to place the future of a great region and its industrial development under the control of land-owners who notoriously play the *rôle* of the "dog in the manger." In effect, then, the decision is that the tillers of land who do work and who must have the water shall not have access thereto or be able to convey the same, if objection be made by owners who will not sell, work their land, or join in allowing work to be done by any one else.

To illustrate how hostile the Ross decision must prove, let me summarize the general situation in the arid region as to the law of water. It is recognized:

(1) That the principle of public control and beneficial servitude, as well as of free access, comes to us by the Code Napoleon and the Roman law, and by the immemorial customs of ancient peoples whether native, conquerors, or colonists. These rights, customs, and laws are guaranteed by solemn treaties.

(2) That, under the practice of equity in dealing with public lands in arid and semi-arid conditions, the United States departments and the judiciary have heretofore held strictly to the law of use and access. The land office recognizes prior appropriation for use; the interior department has systematically protected that, and the Pueblo and other Indians also in their water rights; and as late as 1880 and 1881 the executive ordered troops into Texas and New Mexico to guard rights of this character against encroachments affecting the Mexican and Indian users.

(3) That the United States congress adopted the miners' code, or common law, relative to the use of water, by appropriation, and made the same a part of the federal statutes. This is a distinct recognition of "public concern." It has been broadly interpreted by the courts ever since. Every one of the seventeen States and territories found, in whole or part, west of the one hundredth meridian has adopted the same and wrought it into constitution and statutes. In addition, by law, the customs and regulations of Mexico remain substantially part of the laws of Texas, Oklahoma, New Mexico, Arizona, Utah, Colorado, California, and Nevada.

(4) The States of Colorado, California (by amendment), Idaho, Montana, Nevada, North Dakota, Utah, Washington, and Wyoming have distinctly incorporated the principle of public control into their several constitutions.

(5) The States of Kansas, Nebraska, Oregon, South Dakota, and Texas have done the same by the adoption of recent and elaborate legislation on this whole subject.

A brief and pointed digest of the decisions reached by the courts of the arid States, especially in Colorado, Wyoming, Idaho, and California, will clearly show how far and how deliberately Judge Ross's view places him in antagonism to the general jurisprudence.

If the right of public control and beneficial use thereunder, and of prior appropriation of water, be conceded, it follows, as the day follows the night, that there must also be the right of way for "works of necessity." And it follows as certainly that irrigation works are among those of paramount need. The methods of achieving this use belong to the community. And it is as certain that the judiciary of the States are facing the other way. The right to take and use "private lands" for irrigation purposes is the constitutional law of half the arid States, and the statute law of the remainder. Some are more positive in declaration than others; but all acknowledge and act. Compensation must be made for such right of way. Supposed or hypothetical damages to land other than that actually used are not allowed. In other words, the ditch is "a primary need," and must be allowed. With the water it is to convey, its route and character fall within the lines of public supervision and trust. The "consent" of land-owners is not necessary, for "private ways of necessity" or for "reservoirs, drains, flumes, or ditches," when required for agricultural purposes. Every natural stream, it is declared, belongs to the State. In California, Nevada, and the States of the great plains, the State regulates and controls, as a "public concern," the use of "still" waters and of artesian or other underflow and subsurface supplies. Springs are also recorded. Unappropriated waters are dedicated "to the use of the

people." The ownership—*i. e.*, the control—is "vested" in the State for the public. Colorado courts are, so far, in the front line of such decisions, but they only emphasize—and do not outrun—the others. Appropriation "may never be denied," though limited by the paramount law of use. Preference is, in general, given to agricultural uses; then, in order thereafter, domestic, mining, manufacturing, power. Riparian rights are ignored, or made wholly secondary, their equities alone being considered. Water taken thereunder must be restored to the stream, and owners must use. Water, by all this practice and the importance it assumes, is changed from "a mere incident to the soil" into the condition of a "usufructuary estate." Once used on land, it becomes an escheat thereof. The declaration is made that "it is and always has been the duty" of government "to protect the right of water" in this section, "by priority of appropriation." This right is "prior to legislation," and "exists after patent" as before. It does not matter whether the water and its use are related to the public domain or private demesne. The test of appropriation is always beneficial use. The water taken must be openly conveyed and visibly applied. Streams may be diverted from their usual course by proper methods, not injurious in their working. They may be stored and held for use, such use being, of course, subject to the rights of others. The legal rights of earlier appropriators must not be impeded or injured, nor can storage be permitted to "lessen" quantity, "impair" quality, or "impede" natural flow. Legislation may regulate, but not "prohibit," the means necessary for "beneficial use." It can regulate diversion, but it cannot directly "grant" or "charter" water. Abeyance of use cannot be permitted; the fact works forfeiture of appropriation. Use need not be limited to natural course or valley range; the diversion, when permitted, will allow of transfer from one watershed to another. Total change of route is in no way unlawful; priority still continues, and usufructuary rights are preserved. The legal power to determine rights is incidental to the "regulation of use." The power to "regulate rates," to determine costs, and to define the extent of service, follows logically from these premises. The States of Colorado, Idaho, Kansas, Nebraska, North and South Dakota, Wyoming, and California, have acted, in whole or part, upon this power. Texas statutes, with the territorial laws of New Mexico, and Arizona, operatively bring a similar result. These are all matters of judicial decision and affirmation in a number of States, but are especially present in the reports of Colorado, Idaho, and Wyoming.

So far it will be seen that the adjustments are along the line of persons and things rather than in their relations to persons and property, which, of course, involves profits and returns. The next step is as to

the relation of works, ditches, etc., designed to store and convey for use the natural waters which, under priority of appropriation, the people have the right to command. The judiciary of the arid States—again most clearly that of Colorado, Wyoming, and Idaho—declare that ditch companies are "common carriers." The "reservoir," or "ditch," or "well," or "flume," is not a "consumer." Carrier belongs to the ditch; a "consumer" is the appropriator and user. The carrier may not charge in advance under the term "royalty" (Colorado decisions), as that is a usurpation of the generic "use" always involved in appropriation of water. "Royalty," in the vocabulary of water and ditch corporations, is a term used to indicate the demand for a certain sum per acre,—usually $10,—which is charged for the "privilege" of getting water to the land. It is easy to see how this could grow into a "vested right" barrier to free use. Colorado has definitely put both its judicial and legislative feet upon the plausibility, and declares that it is no part of the "carrier's" remuneration. At least three States—Colorado, Wyoming, and Idaho—have made it an unlawful practice. Common carriers are paid only for service performed. The main contention of the opposing school—that of the right to regard and treat water as a commodity—is thus denied. If the Ross decision stands as law, the commodity character will be achieved by indirection, wherever vacant land is privately owned and the owner is opposed to the present tendency.

The power of securing orderly distribution in equity of all waters is regarded as part of the State's police functions. "Courts," say Colorado judges, "would betray their trust . . . if they should shut their eyes and refuse to see" principles and operations "whose existence and recognition cannot be disregarded without bringing ruin on all." The statutes of all the arid States provide for the protection of works and of their owners; of lands and water users, so far as injury, misuse, pollution, cutting, etc., are concerned. Freedom from taxation is a favor usually granted for a term of years to ditch construction. Diligence is required in the work. Record of the route is demanded. Care in maintenance is to be enforced. Water, once attacked, remains with the soil,—so rule the courts of Colorado, Idaho, Wyoming, Montana, Nevada, Utah, and California. The others are following in the same lines. So also with the return to stream bed of all surplus water, and the decision that seepage waters are part of the natural supply; that flood waters are of the same character; and that reservoir sites, etc., are obtainable only by statute. Colorado and Wyoming provide elaborate machinery for supervision of hydrographic basins and for the government of water use. Kansas has a board of irrigation, investigation, and experiment. Nebraska has a

board and office which are designed to be chiefly of engineering control. Nevada has a board of water commissioners, but so far it has done little. Idaho and South Dakota have State engineers; Washington, an arid-land commissioner; Montana, a board of land and water control. North Dakota has a commissioner of water and forestry. California was the first to authorize the office of State engineer, but it was unfortunately abolished some years since, in a spasm of mistaken economy. Wyoming, among all the arid States, is peculiarly fortunate in its State engineer, who presides also over the State board of control.

By the Carey law one million arable acres are granted to each State wherein irrigation is a prevailing need, provided it is accepted within ten years. Water must be arranged for in permanence, and actual settlers put upon the land, none to occupy over one hundred and sixty acres. There must be twenty acres in actual cultivation, with home residence on each quarter section, ere the State can receive and transfer the patents. Thus there will be at least 6,250 homesteads added to the State's population and resources. It is also required that all funds arising from land sales, etc., above cost, shall be deposited, with approval of the secretary of the interior, as a State trust fund to be used for reclamation purposes.

This is the federal gift and purpose. Under the Mead-Carey law in Wyoming it is provided by the State that the land shall be sold at fifty cents per acre; that the State will contract with construction companies to impound water and distribute the same by proper works; that for so doing it will guarantee efficient payment and profit by (*a*) encouraging and aiding settlement, (*b*) allowing a proper price per acre for the cost of water service, and (*c*) holding a lien on the homestead or acres served till the cost of the water right is paid; and that it will protect the user by providing that, when all the water rights are paid for, the works, *et al*, shall become public property under State supervision and to be administered by the users who are served under the supply thus made and arranged. There are three distinct conditions, then, in this legislation: (1) the general government's direct recognition of the public control and concern in irrigation reclamation; (2) the State's power to prevent extravagant land booming, by means of the small figure it cuts upon the acreage granted; (3) public control, and payment, through users, of a large profit to the contractors who provide the works.

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Overland Monthly. *m.* $3. San Francisco.
Paving & Munic. Eng. *m.* $2. Indianapolis.
Plumber and Decorator. *m.* 6*s.* 6*d.* London
Popular Science Monthly. *m.* $5. New York.
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Rhodes' Journal of Banking. *m.* $5. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York.
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, New York.
Social Economist. *m.* $2. New York.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.

ARCHITECTURE & BUILDING

Richard Morris Hunt.

THE *Architectural Record* for the quarter ending December, 1895, is given up to a review of the works of Richard Morris Hunt by Montgomery Schuyler. The text is a laudatory, but not injudicious, estimate of Mr. Hunt's career as an architect and of the artistic measure of his buildings. Mr. Schuyler regards Mr. Hunt's earlier works as displaying an oscillation from extreme formality to complete unrestraint, and adds that, in alternating, "he has shown no trace of severity in his lively performances, or of gayety in his gravity. In the works of his riper years and his practised powers, he seems to have retained this habit,—by turns to have restrained his designs in classic structures and to have relaxed it in freer architecture. But there is this great difference between the periods,—that, while his more formal works used to be liable to the charge of monotony, and his more exuberant works to that of restlessness, he has learned to combine his qualities, to give animation to works essentially academic, and repose to the children of his invention."

The article is sumptously illustrated, the pictures including many views, both exteriors and interiors, not before published, and offering, perhaps, greater interest to the architect than Mr. Schuyler's admirably-composed essay. The pictures include many views of the famous Biltmore house at Asheville, North Carolina, for Mr. George W. Vanderbilt, which are exclusively published and are certainly among the most notable photographs printed by this periodical. Some of them, it must be confessed, are a disappointment, the point of view being so distant that the vast house seems scarcely more than an incident in the landscape. Some of the larger views, however, give a better idea of the mansion, whose splendid size and unlimited cost have roused great expectations. These expectations are not unrealized, and there can be little doubt that Mr. Hunt's fame will largely rest upon this residence. The motifs are borrowed from the Château de Blois, and, if fault is found with the design,—though Mr. Schuyler does not suggest this phase of it,—it will be from the transposition of the features of the French building, and their rearrangement in a new combination. For example, Mr. Hunt, in his garden front, has introduced as a single design several features which in the original building are well separated and without hint of unity. One's sense of historical accuracy is somewhat hurt by a fresh combination of parts that, in the history of architecture, have a position almost consecrated in their relationship.

Several other notable buildings by Mr. Hunt are also illustrated in this article. Mr. Cornelius Vanderbilt's palatial villa, "The Breakers," at Newport, is shown within and without, the interior displaying a really sumptuous series of apartments, whose rich decorations are, to a large extent, architectural and constructive. These two Vanderbilt dwellings form the most conspicuous features of these illustrations, not only on account of their actual novelty, but because of their real value. The whole series of pictures is a most impressive display of architectural activity, remarkable alike for the variety of the styles in which their author worked, and for the thoroughness of his familiarity with a great quantity of detail. Though Mr. Schuyler finds considerable satisfaction in much of Mr. Hunt's early work, the unbiassed observer cannot but feel that in this great career there has been a very great architectural evolution, and that the early buildings show, to a very slight degree, that mastery of composition and of detail that made many of Mr. Hunt's later buildings among the most notable products of American architecture. As Mr. Schuyler remarks in closing, "the series of works here illustrated, and extending over forty fruitful years, shows

an untiring zeal for a great art, a steadily-increasing skill and power in its practice, and constitutes a sum of achievement honorable to the artist, of good example to his profession, and creditable and useful to his country."

It was fitting that Mr. Henry Van Brunt, the most scholarly architect of America, and the one who, by the grace of his diction, the breadth of his views, and the soundness of his appreciation, has labored more zealously in diffusing a cultured knowledge of his art than any other living American architect, should have been chosen by the American Institute of Architects to render its tribute to the late Mr. Hunt. His memorial address, read at the last meeting of the Institute (*American Architect*, November 2; *Inland Architect*, November; *The Architect*, November 22), is a warmly sympathetic paper. It is a tribute of a friend as well as the estimate of a professional brother, and the interesting personal reminiscences that compose a large part of it, though dealin chiefly with the writer's early association with Hunt as a pupil, make it one of the most interesting and valuable papers that have been prepared on the great architect and his work.

Mr. Van Brunt modestly characterizes his paper as "the unaffected impressions of a man singularly representative of all the best qualities which can adorn an architect and a gentleman; a man to whom the profession in this country, for its own sake, owes a formal tribute of commemoration and acknowledgment; a man who not only won our respect and admiration for what he did, but our affection for what he was."

He points out that "the personal attributes of Hunt gave to his professional character a captivating animation, a frank sincerity, and these qualities, combined with the dignity of his bearing and his manly beauty, made him a notable individuality wherever he moved. His artistic conscience was not a mere instrument of service, to be laid aside when not in use, but an active and animating principle of his life."

Of Hunt's work as an architect Mr. Van Brunt shrewdly observes—and his point must carry consternation to many of those who have written on the subject of his art—that, as to his "professional achievements, an architect in the presence of architects cannot indulge in criticisms with the freedom and confidence of judgment which are displayed by those without professional responsibilities and conviction. We are all of us too deeply committed by practice, too deeply engrossed in the evolution of our ideals, to judge them without sympathy too warm for truth, or, perhaps, without bias too strong for justice." These indeed are wise words, and express at once the feelings of architects towards critics in general and that uncertainty of unbiased opinion which is characteristic, not of architects alone, but of artists of every sort.

Mr. Van Brunt's tribute is beautiful and just; it is one of those rare studies of which it can be truly said that here is the right man with the right subject. Yet we may be sure that its author would more gladly have undertaken any other task that might have been assigned him than the sad duty of pronouncing a eulogy upon his life-long friend.

Modern Building Design.

THAT any sort of modern design is possible by any people but the French and their over-enthusiastic followers in America would probably be a matter of astonishment to the latter gentlemen, who are striving so hard to turn the architectural thought of the United States into artificial and foreign channels. It is a basic principle with the followers of the School of Fine Arts in Paris that all their work—in which the forms of the long-dead Renaissance, or the still more anciently deceased buildings of Greece and Rome, are reproduced over and over again, or slightly modified to suit the new conditions that modern architecture unfeelingly thrusts into the building of our time—is modern in the best sense,— which doubtless means spelled with a capital M, instead of put in quotation marks.

To those who affect this sort of thing, a couple of lectures on "Modern Building

Design," recently delivered by Mr. W. R. Lethaby (*The Builder*, November 2 and 9), would not prove palatable reading; though every broad-minded man who will take the trouble to study them will find them not only highly interesting, but valuable and original. Mr. Lethaby sums up his chief points as follows:

(1) That all buildings carry their characters written on their fronts. (2) That students of architecture must learn to read these documents, questioning the right to exist of this or that so-called ornament or feature. (3) That this reading was proper criticism. (4) That there were only two purposes for a building,—service and delight,—and that instructed pleasure could be derived from a building only when it fulfilled certain positive conditions. (5) That there was now no general interest in building, because design was irrational and workmanship not pleasant. (6) That those, not architects, who had taken the trouble to think about building, said very plainly that they had no pleasure in us, the architects. (7) That there were only two methods of design possible,—the fresh experimental work of an artist thinking of terms in materials, or the re-combination on paper of the results of old artisan work. (8) That a small handiwork knowledge was so far better than none, but generally a fine work of art could only be produced by a workman. (9) That beauty was not a luxury, but was inseparably bound up with quality. (10) That we who were selfishly interested in beauty could not content ourselves with less than the endeavor to bring back beauty to all building, and thereby beautify the earth, and not desecrate it.

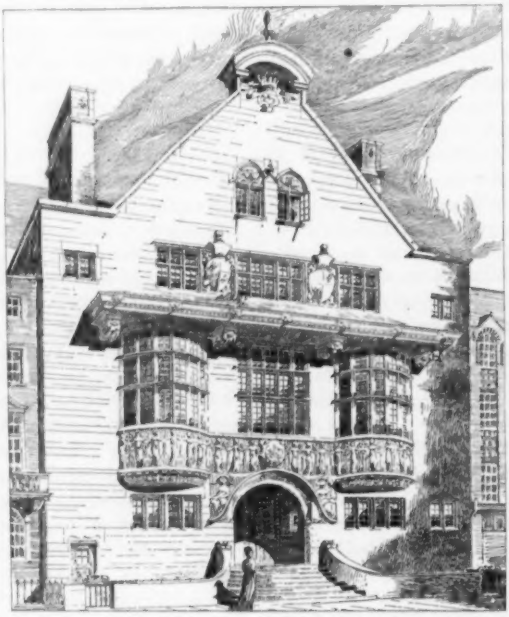
Surely these are reasonable propositions, and few will dispute them. But the author goes further than this. He deplores the study of ancient monuments for their detail and their application and revivification for modern needs, and would do away with the use of such time-honored and consecrated details as the egg-and-dart ornament, and other devices whose employment, we are constantly told by a number of well-intentioned individuals, is very modern indeed. Perhaps we cannot get rid of that ornament all at once; and certainly in its own place it is a very proper and beautiful thing; but at least we can put our students to better work than studying old buildings simply to use them over again! Mr. Lethaby urges that the construction of ancient buildings should be studied,—though it is hard to see how this would be profitable to modern architects, since modern construction is much more complex than anything in the past. Rather than this, it is the spirit of ancient art we need,—neither its forms or its construction, but the spirit that made it beautiful and great. This once understood, we need have no fear for the progress of modern art; nor need we then have a particular sect of architects who affect to call themselves "Moderns."

A Professor on Architecture.

PROFESSOR ALBERT L. BROCKWAY contributes a paper entitled "Architecture from the Architect's Point of View" to the latest issue of the *Architectural Review*. He regrets the unnecessary difference between the public conception of architecture and that of the serious architect. The public expects an infinite resource of utilitarian knowledge, and profound familiarity with construction and materials. These are not unimportant to the architect, but architecture has a trinity resulting in harmony and unity, made up of plan, proportion, and profile. For these the architect sees practically no standards for the public at large upon which to base a judgment of his efforts. The vital part of any composition is embodied in and evolved from the plan. The proportions of the exterior are more or less dependent upon it. It is almost a truism that, having a good floor-plan conceived and well studied out, a good elevation almost necessarily follows.

These, and other propositions of a similar kind, are argued at considerable length, illustrations of the positions defended being made by the help of École drawings and unsuccessful competitions, all representing buildings not built or not intended to be built. The article represents, therefore, the views of the so-called École men in this country, though the au-

thor, from his title, evidently wishes to speak for the whole profession of architecture. He does not suggest that utility may enter into architectural design, nor does he touch upon the relationship between the positions he takes and the small and often unimportant buildings that make up the bulk of the practise of the modern architect. Still, everyone must agree with the professor in his instance of art in the floor-plan, though few will go as far as he does in maintaining that an artistic elevation is almost certain to follow from an artistic plan. That it is more likely to follow is reasonable enough, but the work of the students in the great French school, as the professor implies, is sufficient testimony to the unsafeness of so broad a proposition; since he admits that, while the floor-plan is often all that could be desired, the elevation is frequently unsatisfactory. It is true, also, that the public in general do not understand a plan or its value. But why should they be made to understand a theoretical plan, or be forced to study the plans of unbuildable and unbuilt structures?



DESIGN FOR PUBLIC LIBRARY. PERCY E. NEWTON.

It is impossible for any profession to harmonize its standards with the ideas of the general public, because even educated laymen are destitute of the particular knowledge requisite to judge such standards.

Illustrations of the Month.

THE most notable drawings published in November were those of the second competition for the Minnesota State capitol at St. Paul, of which the winning design is commented on below. The *American Architect* continues its notable series of Urban Club Houses, with beautiful plates illustrating clubs in Philadelphia and Pittsburg. This series surely deserves preservation in collected form, and promises to be the most complete collection of photographs and drawings brought together by any American architectural journal on one subject. In commercial buildings the month brought out little new or important. The *Inland Architect* published a photograph of the Marquette building, Chicago,—a plain, straightforward design, entirely suitable to commercial necessities. It is a pity its authors should have introduced intermediate stories between the base and the superstructure, and again between the latter and the frieze, *à la* New York. *Architecture and Building* published photographs of the Presbyterian building, New York,—a design of much merit and simplicity, but with a basement too high for the superstructure and a gabled story above the cornice which has not the same value in perspective that it had in elevation. The same paper also gave a reproduction of a wash-drawing of the new Bowling Green offices on lower Broadway, New York, accompanied with a quite astonishing essay on the "Hellenistic Renaissance," which,

we are informed, is here applied for the first time to a high building. The illustration is not a good one, and it is, therefore, not quite just to its authors to criticise their performance from it. There is, however, a heaviness in it that is not pleasant, and the value of the vertical lines of the main portion is impaired by the structure apparently built on top of the lower building, though really an integral part of the whole.

In houses, both country and city, there is little of note. The *American Architect* continued its illustrations of Mr. Hoagland's place at Seabright, and, among less important dwellings, illustrated a house for Mr. Newbold at Laverock, Penn., which is a good sort of thing not to do. The design is simple enough, and quite devoid of eccentricity, but the architects at the end of this century do not need to affect the style of the buildings of the end of the last. An agreeable contrast to this American house is "Leenside," at Nottingham, published in *The Builder*. This is a very English design, excellent, quiet, and seemingly just the right sort of house for the formal garden that surrounds it and the river close beside it. A charming little house at Boonton, N. J., appeared in *Architecture and Building*.

The English papers are not up to their usual mark in the interest of their pictures. The most notable single drawing is the general view of the new design for Christ's Hospital Schools, noted below. *The Builder* published, in addition, a charming design for a public library by Mr. Newton, and the selected design for Llandudno

LEENSIDE, NOTTINGHAM. BREWILL & BAILEY, ARCHITECTS.

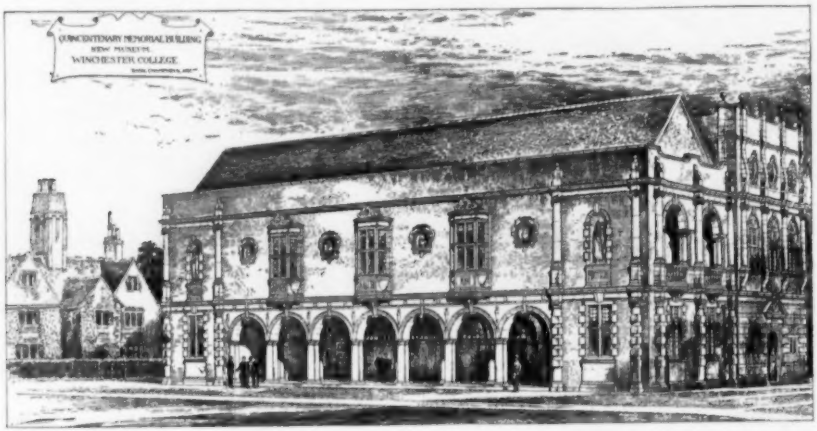
municipal buildings,—the latter very English,—and both interesting examples of recent English architecture, and for that very reason not proper subjects for American reproduction. The design of Mr. Champneys for the Memorial Building at Winchester College will be of interest to the readers of Mr. Statham's notable article on English architecture in the November number of the MAGAZINE.

The design for the City Assembly Rooms

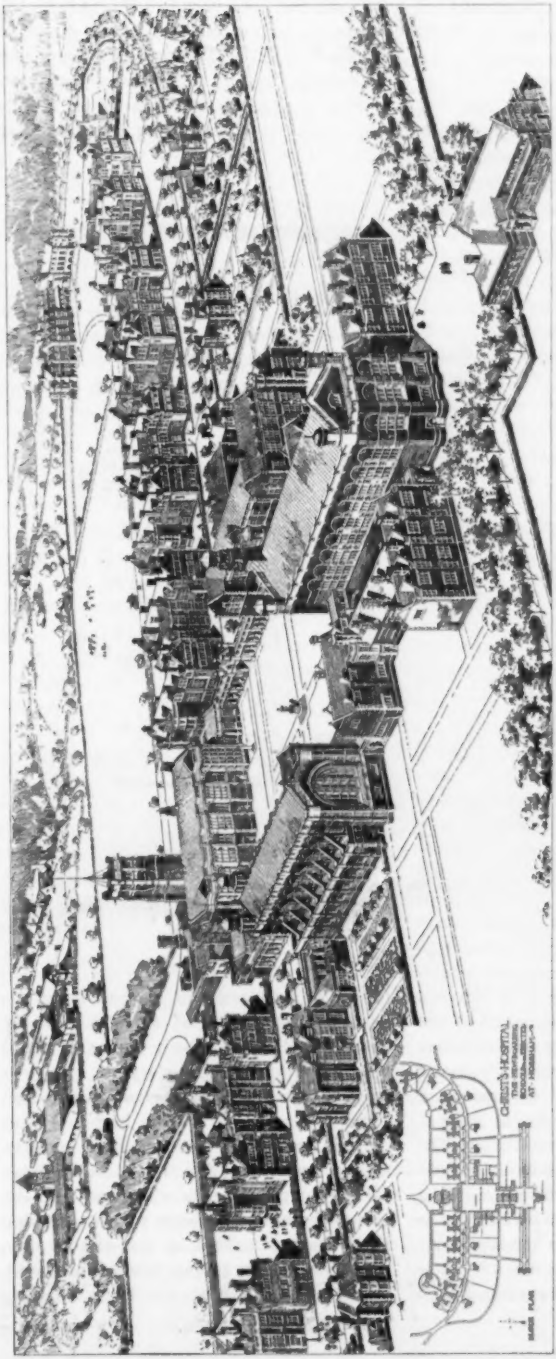
in Birmingham, in *The Architect*, is as bad a design as has been published for some time. The beautiful church of All Saints, Ashmont, Boston, Mass., printed in the *American Architect*, is easily the most notable illustration of church architecture of the month. The very elaborate illustration of the work of Richard Morris Hunt, published in the new number of the *Architectural Record*, is referred to above.

MR. NEWBOLD'S COUNTRY HOUSE, LAVEROCK, PA. GEO. T. PEARSON, ARCHITECT.

THE general view of the design for the new Christ's Church Hospital Schools, Horsham, England (*The Builder*, Nov. 2), illustrates one of the most notable recent English competitions for a great public building. The question was decided more than a year since, and the award made to Messrs. Ashton Webb and Ingress Bell, who have come into unusual prominence within the last few years by reason of their successes in a number of important competitions. Unfortunately for the architects and for the institution some difficulties concerning funds have postponed the beginning of this work.



QUINCENTENARY MEMORIAL BUILDING. NEW MUSEUM BUILDING, WINCHESTER COLLEGE.
BASIL CHAMPNEYS, ARCHITECT.



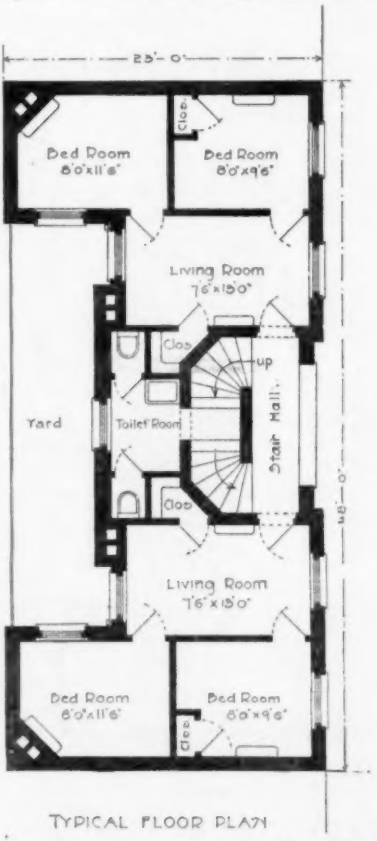
GENERAL VIEW OF DESIGN FOR THE NEW CHRIST'S HOSPITAL SCHOOLS. MESSRS. ASTON WEBB & INGRESS BELL, ARCHITECTS.

The competition attracted attention by reason of the eminence of the architects who took part in it and from the great size and difficulty of the problem. The authors of the successful design devised an exceedingly clever plan, with the general rooms, dining-hall, school-rooms, and administrative and other buildings in the centre, and isolated halls or houses stretching away on either side of the central group, the whole forming a vast segment flattened in the centre. The design is thoroughly collegiate and as thoroughly English, and picturesquely varied yet the different parts are so skilfully welded together as to form an entirely homogeneous and united work. Its chief merit is the plan, which was markedly superior to any other submitted in the competition, and which, in the working out, has been treated in a highly original, but traditional, manner. The design is interesting also as offering a problem quite different from those which come before American architects, the purpose of the buildings being as British as their art. For a great educational establishment it is doubtful if all England contains so important a group as this will be when built,—surely none so modern.

THE *American Architect* (November 2) reproduces from the May number of the *Moniteur des Architectes* a view of a design submitted by M. Esnault Pelterir for a Palais aux Champs-Élysées in the first competition for the Paris Exhibition of 1900. It is a grandiose structure in two symmetrical parts, separated in the center, but connected by a wide spreading dome. The conception is novel, and the plan, which provides for the opening of two new avenues and a vista from the Palais de l'Élysée through the central dome, is superbly worked out. The elevation, of which only fragmentary parts are shown in the view printed in the *American Architect*, provides for a basement, plainly treated with large round headed windows and doors, and a main story, in which a series of similar windows are carried behind a colonnade of coupled columns, broken, at intervals, by decorated solid piers. Adjoining the dome is a decorated pavilion, which is repeated at the further extremity of the straight front, beyond which the building is continued in a curve, with an ornamental pavilion in the axis and a semi-domed roof of glass, which closes the high semi-circular roof of the main part.

The building is apparently well suited for exhibition purposes, being of a sufficiently ornamental architecture to serve as the home of beautiful things. The most striking feature is the vast dome connecting the two parts. Of practical utility this has none at all, for, though it joins the two parts of the building, it does so at such a height as to afford little shelter in stormy weather. As an ornamental device, it certainly has the merit of novelty, while its juncture with the roofs of the adjoining parts gives a unity to the upper part of the building that is necessarily absent from the lower. The dome is of iron and glass and the buildings of stone; were it not for this fact, we might be tempted to believe that this was a Parisian amplification of a design for an exhibition building in Cook county, Illinois. The scheme is more attractive in plan than in elevation.

TENEMENT houses are so rare in Philadelphia, and such very bad things in themselves, that their erection in the "city of homes" must be deplored by every one interested in the housing of the poor. Some time since, the "Benevolent Building Association" was organized in that



TYPICAL FLOOR PLAN

city to buy up and remove bad buildings used by the poor, and replace them by better buildings in which the rent would not be higher. Considering the extremely low price at which small houses of good description can be had in Philadelphia, this experiment would seem to be a hazardous one. The *American Architect* (Nov. 30) publishes a view and plan of one of the new buildings recently erected by Wilson Brothers & Co. of that city. The plan, which is reproduced herewith, is interesting in the contrast it offers to

the typical New York tenement house. In New York such a building is long and narrow, with the narrow front on the street. In the Philadelphia example the broad front is on the street, and a much more sanitary and convenient plan is possible.

THE State Mutual Life Assurance Company building, Worcester, Mass., is a large square structure (*American Architect*, Nov. 2), nine stories high and open on three sides to as many streets. It is in the Renaissance style, and is a sufficiently correct application of that style to the purposes of commercial design. That is to say, if we must use the Renaissance for modern office-buildings, the way to do so is illustrated in this edifice, where it is employed in the detail, for the window frames, cornices, entrances, and the like. The architects have wisely discarded the use of ornamental columns and pilasters, and designed the upper part of their building with commendable sobriety. The richest stage—and here the ornament is confined to the monumental windows—is the second floor, which contains the offices of the company, and which is, therefore, the main floor. The detail is scarcely discernible in the general perspective, but is shown in some smaller drawings, published at the same time, to be entirely satisfactory both in quantity and in application.

STATE MUTUAL-LIFE ASSURANCE COMPANY BUILDING, WORCESTER, MASS. PEABODY & STEARNS, ARCHITECTS.

Yet, as a whole, this design is not quite satisfactory. That it will seem better in the actual building than in the drawing may safely be counted on, for the shortcomings of the earlier sketch, in the hands of such competent architects as its authors, will certainly be removed with erection. The design suffers from proportions not altogether happy. It is not quite high enough for its width and breadth, and the horizontal divisions are not pleasing. The second story really includes two stories' and, while it may have been necessary to emphasize the situation of the company s offices, the treatment followed is not good. In the design these two stories form but one, with an apparent height greater than the other portions permit.

TWO competitions have now been held for the purpose of securing a design for a new State capitol at St. Paul, Minn. The second one has just been concluded, and a number of the designs, successful and otherwise, have been published in the architectural papers (*Inland Architect*, Nov., the five premiated designs; others in the *American Architect*, Nov. 16 and 30). The award in this competition was made by Mr. E. M. Wheelwright, of Boston, whose recommendation that the design of Mr. Cass Gilbert be chosen has been accepted by the committee.

Of the designs published, that by Mr. Gilbert is undoubtedly the best. It is dignified and quiet, yet sufficiently monumental to be satisfactory for its purpose as the capitol of a great and growing State. In this respect it offers a considerable contrast with some of the other de-

signs, which show that fussiness and over-elaborateness of effect which so many architects regard as part of the natural character of the Renaissance. For it need hardly be said that all the designs thus far published are in this style of architecture; and, indeed, in a competition to be decided by an architectural expert, any other style would have been out of place and an act of needless folly on the part of the designer. Thus much, at least, the Frenchifying tendency of the Beaux Arts men has accomplished, and it would be interesting to know if they regard the Minnesota competition as illustrating their ideal and satisfactory to their ideas.

The accepted design shows a rather long building, whose main front is broken only by the projecting center and very shallow wall-pavilions at each end. A two-story basement, which in the centre is provided with a broad flight of steps to its upper story, supports the main wall, divided by Corinthian pilasters, between which are large framed windows with smaller ones above them. The center is treated as a pavilion, with a colonnade of coupled columns between solid ends. This carries a paneled attic with groups of sculpture above, while the wing walls are capped by a cornice and balustrade. Over the center rises the dome, a large and dignified structure, whose drum between the windows is divided by piers faced with coupled columns. It suffers somewhat from its isolation. In the perspective sketch it rises directly from the center of the roof without the assistance of a single feature that leads up to it. This, however, is a minor misfortune that is more than offset by the quiet restraint in the whole design, to which, unquestionably, much of its success is due.

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ENGINE HOUSES. At Hartford, Ct., by F. M. Comstock, Archt. and Build., Nov. 9. — At Hackensack, N. J., by W. A. Lambert, ibid.

HISTORICAL AND MISCELLANEOUS. Stair to Church, Brindlach, Amer. Archt., Nov. 9.—Pulpit in Schlosskirche, Wittenberg, ibid.—Sketches by J. W. Case, ibid.—Old Gov. Brooks' House, Medford, Mass. (views, plan), ibid, Nov. 23.—Gray's Inn Chapel, London (interior), ibid, Nov. 30.—St. Georges de Boucherville, Archt., Nov. 8, 15, 22.—Window in Mun cipia, Monza (eleva-

tion, plan), Brickbuilder, Nov.—Central Balcony, Tremont Temple, Boston, Mass., by Blackall and Newton, ibid.—St. Martins, Wareham (views, sections, plan), by C. R. Macintosh, Brit. Archt., Nov. 8.—Doorway at Rome, Ironwork at Siena, sketches by H. S. East, ibid, Nov. 15.—Choir Screen, St. David's Cathredal, drawn by T. G. Jackson, Builder, Nov. 23.—Dutch Windmill, Truesdell, Wis., drawn by J. T. W. Jennings, Inland Archt., Nov.

HOSPITALS. Free Hospital for Women, Brookline, Mass., by Shaw & Hunnewell, Amer. Archt., Nov. 9.

HOUSES, CITY. Of late W. Burgess, Kensington, London, by himself, Archt., Nov. 8.—New Picture Gallery for Sir Frederick Leighton, London (interior), by G. Aitchison, Builder, Nov. 9.—For W. D. Marsh, Evanston, Ill., by J. T. W. Jennings, Inland Archt., Nov.—For P. D. Armour, Jr., Chicago, by F. W. Perkins, ibid—Houses in Chicago, by Pond and Pond, ibid,—For H. Thomson, Chicago, by H. Shaw, ibid.—House in Chicago, by Shepley, Rutan and Coolidge, ibid.

HOUSES, COUNTRY. For J. C. Hoagland, Seabright, N. J. (gateway, interiors), by Shepley, Rutan and Coolidge, Amer. Archt., Nov. 16.—For Mr. Newbold, Laverock, Pa., by G. T. Pearson, ibid.—Fieldstone Terrace, Brookline, Mass., ibid.—"St. Keverne," Harrow on the Hill, by A. Mitchell, ibid, Nov. 23.—For J. D. Safford, Springfield, Mass., by E. J. Parlett, ibid, Nov. 30.—For Mrs. Frederick Power, near Coleshill, by E. C. Bewley, Archt., Nov. 15.—Bedston Court, Birkenhead, by Grayson & Ould, ibid, Nov. 22.—Country Residence (view, interiors, plan), by E. G. W. Dietrich, Archt. and Build., Nov. 2.—For Mr. E. P. Smith, Greens Farms, Ct., by Jardine, Kent, and Jardine, ibid, Nov. 16.—For W. S. Johnson, by E. G. W. Dietrich, ibid, Nov. 30.—At Boonton, N. J., by Boring & Tilton, ibid.—Sketch for Suburban Home (with plan), by I. C. Eagles, ibid, Nov. 9.—At Woodside Park, N. Y., by W. T. Walker, Builder, Nov. 2.—Entrance Front of same, ibid.—"Leenside," Nottingham, by Brewill and Baily, ibid.—At Sutton Coldfield, by E. Newton, ibid, Nov. 23.—For Judge Spinks, Swan Lake, Okanagan, B. C. (elevations, plans), by R. M. Fripp, Canadian Archt., Nov.—For Arthur Thompson, Glen Road, Rosdale, ibid.

LIBRARIES. Proposed Fisk Memorial Library, Wrentham, Mass., by D. H. Woodbury, Amer. Archt., Nov. 9.—Proposed Public Library, Fall River, Mass., by N. C. Smith, ibid.—Accepted Design, West Ham Technical Institute and Library (view and plans), by Gibson and Russell, ibid, Nov. 2.—Second and Third premiated design for same, ibid, Nov. 16.—Public Library, by P. E. Newton, Builder, Nov. 9.

MINNESOTA STATE CAPITAL, Alternative Design, First Competition, by W. B. Dunnell Amer. Archt., Nov. 16.—Design, with plans, First Competition, by H. T. E. Wendell and J. J. Humphreys, ibid, Nov. 30.—Accepted Design, Second Competition (view & floor plans), by C. Gilbert, In. Archt., Nov.—Second Prize, by G. R. Mann, ibid.—Third Prize, by Traphagen & Fitzpatrick and E. P. Bassford, ibid.—Fourth Prize, by C. H. Johnston, ibid.—Fifth Prize, by H. W. Jones, ibid.

MONUMENTS. Sun Dial, Walton House, by Brewill and Baily, Amer. Archt., Nov. 9.—To Achille Testoin, Lille, France, by Bonnier & Cordonnier, ibid.—John Hooper, Memorial Fountain, Brooklyn, by G. M. Huss, Archt. and Build., Nov. 2.—Washington Memorial Arch, Washington Square, N. Y., by McKim, Meade and White, ibid, Nov. 23.—Competitive Design for Chattanooga Battle Field, by E. Roth, ibid, Nov. 30.

MUNICIPAL BUILDINGS. Public Baths, Washhouses & Municipal Offices, Deptford, by T. Dinwiddy, Amer. Archt., Nov. 9.—Llandunno Municipal Buildings (accepted design), by T. B. Silcock, Builder, Nov. 9.

MUSEUMS. Government Museum, Bangalore, Amer. Archt., Nov. 2.—Palais aux Champs Élysées, Paris, by Esnault Pelterie, ibid.—Quincentenary Memorial Building, New Museum, Winchester College, by B. Champneys, Builder, Nov. 16.—Glasgow Art Galleries, Competition Design, by J. Lindsay, ibid, Nov. 23.

PUBLIC BUILDINGS. The Mayo Hall, Bangalore, Amer. Archt., Nov. 2.—Springfield (Mass.), City Market, by Gardner, Pyne & Gardner, ibid, Nov. 9.—City Assembly Rooms, Birmingham, Eng. (view and interior), by E. Nicol & Goodman, Archt., Nov. 15.

SCHOOLS. New High School, Somerville, Mass., by Hartnell, Richardson and Driver, Amer. Arch., Nov. 9.—Door, Faculté des Sciences, Sorbonne, Paris, by Nénot, ibid.—High School, Emporia, Kansas, by H. W. Jones, ibid, Nov. 23.—Free Public Library and Manual Training School, Hoboken, N. J., by J. Ross, ibid, also, Nov. 16.—District School, Bayport, N. Y., by C. K. Birdsall, Archt. and Build., Nov. 9.—Trinity School, N. Y., by C. C. Haight, ibid, Nov. 30.—General View of Design for new Christ's Hospital Schools, Horsham, Eng., by Webb and Bell, Builder, Nov. 2.

STUDENTS' WORK. Sanitarium Hotel, Thesis Design, by E. J. Moeller, Archt. & Build., Nov. 16.—Theatre for Cantatas, by C. A. Fullerton & W. M. MacCafferty, ibid, Nov. 23.—Garden Pavilion, R. I. B. A. Tite Prize, by W. T. Connor, Brit. Archt., Nov. 1.—Picture Gallery R. I. B. A. Soane Competition, by G. L. Morris, ibid, Nov. 8.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

*2473. The Value of Good Architecture in Cities. Barr Ferree (Comparing the architec-

We supply copies of these articles. See introductory.

ur al taste of America and Europe, and pointing out the commercial and esthetic advantages accruing to a people who practice good architecture). Eng Mag–Jan. 4300 w.

*2479. Some Danish Churches. Ill. H. Rose (An account of a tourist's trip with brief architectural studies). Builder–Nov. 2. 2500 w.

*2480. Modern Building Designs. W. R. Lethaby (An abridged report of a lecture given at the Central Art Department of the Technical Education Board, London). Builder–Nov. 2. 2400 w.

*2551. The works of the Late Richard M. Hunt. Ill. Montgomery Schuyler (A review of the career and works of this distinguished architect, instructive and written in pleasing style. It is copiously illustrated by views of "The Breakers," "Ochre Court," "Belcourt," "The Marble House," and other notable places and buildings). Arch Rec–Oct-Dec. 19000 w.

2578. The Effect of Fire on a Partially Fireproofed Building (Showing that when the beams are not entirely covered by fire-proofing material, the structure is not properly fireproof, as was shown by the beams giving way in the case of the Manhattan Bank Building in the late New York fire). Eng News–Nov. 14. 350 w.

†2595. The Union of Building Trades' Schools with Schools of Architectural Design. Robert D. Andrews (Synopsis of a paper read at the 9th An. Con. of the Nat. Assn. of Builders, at Baltimore. Outlining the method by which such union may be made valuable and explaining why it seems desirable). In Arch–Nov. 3300 w.

*2602. Modern Building Designs. Positive Conditions. Mr. Lethaby, with editorial (Abstract of third lecture, with short discussion). Builder–Nov. 9. 5500 w.

*2608. Inaugural Address of F. C. Penrose before the Royal Institute of British Architects (Touching upon the relation of architects to the public; building surveyors under local authorities; competitions in general; competitions and their promoters; development of architectural education; the metrical system of measurement, &c). Arch, Lond–Nov. 8. 9000 w.

*2731. Pompeii. Talfourd Ely (An address, illustrated by lantern slides, given before the Architectural Asso. Descriptive of this city, its buildings, works of art, &c). Arch, Lond–Rev. Nov. 15. 4000 w.

*2732. Domes (A consideration of noted domes, such as St. Sophia, St. Peter's, &c). Arch, Lond–Nov. 15. 3000 w.

*2733. Apprenticeship (Editorial on an article in the *London Technical Education Gazette* which was a summary of results of a systematic inquiry into the state of apprenticeship in the various trades of London, and views of various employers regarding the possibility of developing the system in the future. The article deals only with the building trades). Builder–Nov. 16. 2800 w.

*2734. An American Architect on Renaissance Architecture (An extract from an article by R. S. Peabody in the *Atlantic Monthly*, showing how the architecture of this period affects the mind of an eminent architect). Builder–Nov. 16. 1100 w.

*2735. Architectural Education in the States (A report presented at the An. Con. of Amer. Inst. of Arch., by the Committee on Education). Brit Arch–Nov. 15. 1800 w.

2840. Engine-House for Fire Department, New York City (Detailed illustrated description of building). Eng Rec–Nov. 30. 900 w.

2881. Specifications from an Architect's Point of View (A paper read before the Arch. Assn. by B. F. Fletcher in the absence of Mr. Pinks, the author. Critical examination of the specification as it is; consideration of the necessity of specifications; and suggestions for their abolition as separate documents in a contract). Arch & Build–Nov. 30. 4000 w.

*2903. Old Architecture in Greater London (Descriptive of interesting English architecture in and near London). Ill Car & Build–Nov. 22. 2000 w.

*2904. Imitating Woods (Directions for imitating oak, mahogany, satinwood, walnut, rosewood, etc). Ill Car & Build–Nov. 22. 2100 w.

2905. Study of the History of Architecture (Extract from a paper describing the methods by which the history of architecture is taught at Columbia College). Am Arch–Nov. 30. 2800 w.

*2906. Building and Sanitary Construction. Banister Fletcher (Abstract of the third lecture of a series being given at Carpenter's Hall to students and clerks of works). Arch, Lond–Nov. 22. 2500 w.

†2908. The Sculptured Columns of the Temple of Diana at Ephesus. Alex. S. Murray (Paper read before the Royal Inst. of British Archs., with illustrations and discussion). Jour of the Roy Inst of Brit Arch–Nov. 21. 9000 w.

†2936. Topical Discussion—Durability of Iron in Modern Building Construction (Processes, investigations, experiences and suggestions. (Pro Eng's Club of Phila. July–Oct. 9500 w.

*2954. The Fire Hazard in Mills. James Goldie (Principles of fire-proof and of slow-burning construction, applied to flour-mills and the supply of means for extinguishing fires in this class of structures). Am Miller–Dec. 1900 w.

†2955. Durbar Hall and Recreation Rooms for His Highness, Sawai Mahindra, Maharaja, Sir Pretap Singhjee, Sar-Amad Rajgan of Bundelkhand, K. C. I. E. (Illustrated description). Ind Engng–Nov. 2. 900 w.

*2976. The Municipal Control of Buildings. G. B. Longstaff (The necessity discussed, and the buildings considered from the points of view of stability, fire, health, position and mutual relations, convenience, and beauty. Paper read before the Arch. Assn. London, with discussion). Builder–Nov. 30. 11000 w.

*3000. Architectural Competitions and Public Buildings. William Henman (The concluding portion of a presidential address at a meeting of the Birmingham Arch. Assn., with editorial). Brit Arch–Nov. 29. 2400 w.

We supply copies of these articles. See introductory.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Water Power, Its Generation and Transmission.

IN a paper read before the American Society of Mechanical Engineers by Samuel Webber the question of reutilizing the power stored in water supplies is ably discussed. *The Iron Age* (Dec. 5) contains the paper, from which we abstract as follows:

"An annual rainfall of 42 in. is equal to 267,409 cu. ft. per day on a sq. mile, or 3.09 cu. ft. per second; and, if we take one-third of this, or 1 cu. ft. per second, from each sq. mile of drainage area, we arrive at the supply which can usually, by the aid of storage, be relied upon.

"The paper briefly dwells upon the development of the turbine wheel, and presents the following table as showing the difference in quantity of water used and power obtained by a number of wheels of nearly the same diameter, under the same head of 26 ft. beginning with the Boyden Fourneyron, and ending with the Victor:

Make of Turbine.	In. Diam.	Cu. ft. water per sec.	Horse-Power.
Boyden Fourneyron ..	36	22.95	55
Risdon.....	36	35 45	89
Risdon "L. C.".....	36	48.27	121
Risdon "D. C.".....	36	80	199
Leffel, Standard.....	35	40.45	96
Leffel, Special.....	35	60	148
Tyler.....	36	40.7	95.8
Swain.....	36	58.2	140
Hunt, "Swain bucket"	36	48.8	121
Hunt, New Style.....	36	98	239.74
Leffel, "Samson"....	35	109.1	264
"Hercules".....	36	107 6	253.5
"Victor".....	35	108 8	266

"This enormous difference in productive effect in wheels of the same diameter shows the great economy of the latter type of turbines, particularly as all the wheels above named have a proved efficiency of 80 per cent, and some of them have given more; such as 87 per cent. for the Risdon, tested by Edward Sawyer of Boston, at Crompton, R. I., and by the writer at the Centennial; 87 per cent. for the Hercules, tested by Professor Thurston; 84 per cent. for the Collins, by the same authority; 84 per cent., nearly, for the Swain, by Mr. Francis; 84 per cent. for the Geyelin and the Hunt, tested by the writer; and 88 per cent. for a 15-inch Victor, by the same, but this was so small a wheel that the test cannot be depended on.

"As showing the cost, we take the following in regard to the Concord Water Power Company, on the Merrimac river, at Concord, N. H. Here the power developed is at a minimum 3,300 h. p., on an average 5,000 h. p., from a fall of 22 ft. The wheels are Rodney Hunt turbines, set in pairs on horizontal shafts of 400 h. p. each. The cost has been as follows:

700 acres land, and flowage rights....$	20,000
Dam and abutments.....	141,015
Canal, 60 ft. wide.....	27,363
Head gates.....	16,675
Waste weir.....	5,220
Making an investment for water of..	$210,273

or $63.72 for the minimum amount of power, or $42.05 for the average amount of power. To this is to be added: pits and foundations put in for 2,000 h.-p., $15,000, or $7.50 per h. p.; wheels put in for 1,600 h. p., $12,225, or $7.66 per h. p., making a total, for the minimum flow of water, of $78.88 per h. p., and, for the average flow, of $57.75 per h. p. Now, if we base our calculation of cost on the minimum flow, and allow interest, 5 per cent., sinking fund, 2½ per cent., repairs, 1½ per cent., taxes, &c., 1 per cent., we get a total annual cost of 10 per cent., or $7.89 per h. p., to which add oil and attendance, 75 cents, making $8.64. As this power is to be transmitted, in part, at least, to Concord by electricity, the cost of such transmission, on which I do not assume to be authority, will have to be added to this. If, on the other hand, it is to be partially used near at hand, it is safe to say that the cost of transmission by shafts and belts would not increase to over $ 10 per h. p."

Union Pacific Railroad Bridge Specifications for 1895.

THESE standards are classed by George H. Pegram, chief engineer, under the heads of Dimensions, Loads, Forces, Details, Workmanship, Material, Painting, Erection, Inspection, and Drawings, the last five of which present no new features. Mr. Pegram, in *The Engineering News* (Nov. 16) writes: "You will note that I treat the live load in all cases as a uniform load, designed to include the effects of impact. This gives practically the same results as using the wheel loads in the old way, with a large saving in labor of computing stresses." The following extracts from the specifications include some of the most interesting and important features:

"The width, center to center of trusses, shall never be less than one-twentieth of the span length.

"Tower spans in trestles must not be more than 40 ft. long.

"Top chord panels shall not have a greater length than 1½ times the width between chord centers.

"Preference will be given to girders which have a greater depth than one-twelfth and trusses one-eighth the span length.

"One-third of the dead load shall be assumed as concentrated at the panel points of the unloaded chord.

"Unless otherwise specified, the heavy loading shall be used.

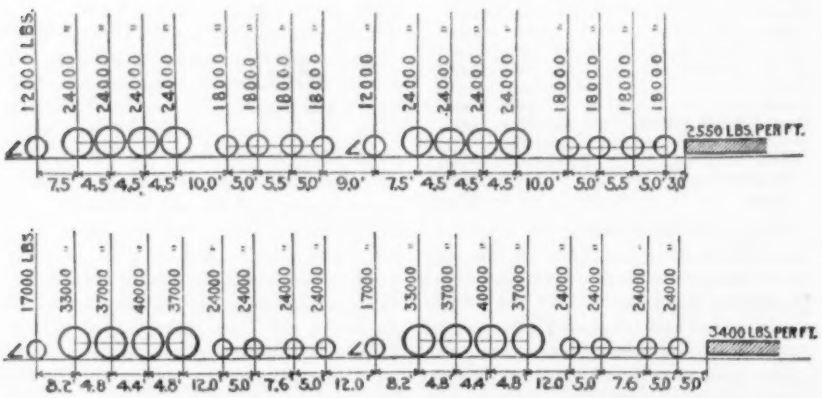
"The heavy loading shall be a uniform load of $\left\{\frac{160{,}000}{S}+3{,}400\right\}$ pounds per linear foot of track, in which S=the span length for girders and trusses; the panel length for stringers, end floor beams, and similar members; the sum of the lengths of adjacent panels or spans for intermediate floor beams, suspenders, subposts, cross-girders, and piers.

"The above heavy loading is the equivalent of two coupled engines and train, shown in the preceding diagram, with additions for impact varying from 50 per cent. at 15 ft. length of span to 10 per cent. at 100 ft.

"The light loading shall be a uniform load of $\left\{\frac{120{,}000}{S}+2{,}550\right\}$ pounds per linear foot of track.

"Note.—This is three-quarters of the heavy loading, and consequently the live load stresses in all parts of spans will be three-quarters as great, which consideration will facilitate the preparation of strain sheets where both loadings are used for spans of the same dimensions.

"The above light loading is the equivalent of two coupled engines and train, shown in the diagram, with additions for impact varying from 80 per cent. at 15 ft. length of span to 10 per cent. at 100 ft.



TRAIN BASIS FOR LIGHT AND HEAVY LOADING.

"Note.—The greater addition for impact in small spans for the light loading serves to cover stresses induced by the greater concentration of weight in tank and passenger engines.

"The centrifugal force on curves shall be assumed to act 5 ft. above base of rail, and shall be computed for a speed of $(50-2d)$ miles per hour, in which d is the degree of curve.

"A wind force of 30 lbs. per sq. ft. shall be assumed to act upon the surface of the floor, double the surface of other parts, and a moving train surface 10 ft. high.

"Stresses from dead load and wind force shall be taken at unit stresses 50 per cent. greater than those hereinafter specified for live load and centrifugal force.

"The stress per sq. in. for live load and centrifugal force shall not exceed the following:

"*Tension.*—Rolled bars and flanges of girders, 10,000 lbs.; plates and shapes, 8,000 lbs.

"*Compression.*—All compression members, which must not be over 48 diameters long,

$$\frac{8{,}000}{1+\frac{L^2}{18{,}000\ R^2}}$$

in which L=length between supports in inches. R=least radius of gyration in inches.

"Field rivets and adjustable members, to be taken at 20 per cent. less than the stated stresses.

"Stresses in steel shall be taken 15 per cent. greater than given above for wrought iron.

"Provision shall be made for expansion and displacement by an allowance for motion of 1 in. for each 70 ft.

"All spaces must be provided with drains or filled with improved waterproof-material to effectually prevent the lodgment of water.

"In steel and forged-iron members the section around pinholes in tension members shall not be less than two-thirds the section of such members.

"Bends in iron must be made hot. Bends in steel must be made cold, and the whole piece subsequently annealed.

"Steel must be made by the open-hearth process, and shall contain not more than .08 per cent. of phosphorus.

"Samples shall give the following minimum results when tested, *viz.*: ultimate strength, 62,000 lbs. per sq. in.; elastic limit, 34,000 lbs. per sq. in.; elongation in 8 in., 22 per cent.; reduction of area, 44 per cent.

"Full-size eyebars shall have a minimum ultimate strength of 60,000 lbs. per sq. in., and elongation of 15 per cent. in 15 ft."

Prevention of Fire.

As an excellent example of enterprising management, we here notice the circulars sent out free by the Boston Manufacturers' Mutual Fire Insurance Company, through Mr. Edward Atkinson, its president. It is certainly not a new idea that it is to the interest of insurers to prevent losses by fire, yet it is not common for insurance companies to go to the expense of making experiments to determine for their members the best methods and appliances to use in preventing fires. "Circular No. 63," as in the case of all others of the series, is issued for free distribution, and treats of "Fire Retardents on Wooden Surfaces." This is a subject of interest to property owners but still more so to designers and builders of all forms of structure. The architect and civil engineer unite in producing structures as nearly fireproof as conditions will permit. Speaking of the experiments performed by his company, Mr. Atkinson says: "The object of these tests has been to determine the relative value of materials which can be put up without being subject to the objections applying to plastering." If the timber and plank are varnished, the danger of catching fire is increased, even though the wood itself is not highly combustible. "The first rule for avoiding the rapid spread of fire on wooden surfaces is therefore TO FORBID ABSOLUTELY THE SMEARING OVER OF THESE SURFACES WITH ANY OF THE ORDINARY TYPES OF COMBUSTIBLE VARNISH. The next remark may be that some of the fire-proof paints, so-called, will retard ignition from small cause nearly as well as a

good coat of well-made whitewash; there are one or two which will retard a fire a little longer than whitewash, when applied to inside surfaces, but, as against high heat, neither paint of any kind nor whitewash will serve any considerable length of time. Our undertaking has, therefore, been to find materials of sufficient thickness and of sufficient non-heat-conducting properties to retard both the spread of fire from small cause and also to retard the combustion of the wooden surfaces as long as possible under high heat." All the specimens received from manufacturers were tested under similar conditions. "All were cut seven inches square, and each was applied to a piece of soft pine wood, seven inches square and one-half an inch thick. The wood was carefully inspected, and was free from knots, shakes, and splits. The specimens were tacked to the wood along the edges where the tacks were not exposed to the heat. The pieces of pine thus protected by the material to be tested were exposed to a blast of hot gases from a brick furnace. By the use of several Bunsen burners and wire nettings a column of gases six inches square and of nearly uniform temperature could be directed upon the under side of the specimen. The temperature was determined and kept constant by a Le Chatelier pyrometer. A series of tests was made, first, by exposing the specimens to the blast at a temperature of 1,600 F. for ten minutes. The efficiency is estimated from the depth of charring in the wooden backing. A second test was made by exposing each specimen to the blast at a temperature of 2,400 F., until the backing caught fire. The efficiency is rated on the time elapsing before ignition. The two ratings are identical, excepting in the case of the H. W. Johns Co.'s 'Superator.'"

The results of the individual tests are given in Table I., not produced here.

Table II. contains a list of the best materials in the order of their efficiency. Column 1 gives the name of the material; column 2, the grade or thickness; column 3, the depth of charring; and column 4, the time elapsing before ignition of the wooden backing.

TABLE II.

1	2	3	4
Material.	Grade.	Depth of charring.	Minutes before ignition.
Salamander.....	No. 4.	0	14
Wall Board.....	Cement finish.	0	8
" "	Plaster finish.	0	8
Fire Felt.....	¼ inch.	0	7
Salamander.....	No. 3.	1/16 in.	5
Wall Board	Plain.	1/16 "	5
Air Cell.....	3 ply.	1/8 "	4½
Wall Board.....	Fancy.	1/8 "	4
Fire Felt.....	1/8	¼ "	3½
" "	1/8	...	3

"We may add that the question whether or not a fire is to be destructive is usually determined in the first five minutes. Hence it follows that any material which can be put upon wooden surfaces at a reasonable cost, and which will hold a fire for five minutes or more, will probably serve its purpose by enabling an effective fire department to reach the place and to extinguish the fire."

The true method of protecting iron and steel from the destructive effect of heat either within the building or striking upon the building from without is yet but partially solved. An organization has lately been made for making the most complete and adequate tests.

Montreal, Ottawa, and Georgian Bay Canal.

WHILE the New York State ship canal is under discussion, our Canadian neighbors have again revived a similar scheme, —that of connecting Lake Huron with the lower St. Lawrence river. Mr. Macleod Stewart, in *The Canadian Engineer*, comments upon the scheme as "involving no unreasonable expenditures," and one "in the carrying on of which no unusual engineering difficulties are to be met with; and those difficulties which do exist are within certain defined limits, and already known with a fair degree of accuracy from surveys made at different times." Speaking of the various routes, he says: "The Ottawa river is supremely suited to become a great highway for traffic. Geologists say that formerly a large portion of the waters of the great lake region found their

way eastward through the Ottawa, which probably constituted their main channel until an upheaval of the country about Lake Nipissing, and a gradual draining of the basin, led to their gradual division to the present course through the Niagara river." This region "would afford an open navigation often preferable to that of the great lakes themselves, because of the immunity from the effects of storm and head-winds enjoyed on these land-locked waters." . . . . Mr. Shanly made a survey (1858) estimating the complete cost at that time of 58 miles of canal construction at $18,500,000. Mr. Clarke (1860) estimated the cost as not more than $15,000,000, in which several other engineers concurred. The former plan provided for a canal 10 ft. deep, while the latter contemplated a depth of 12 ft. These, of course, were old-time estimates, which superior facilities to-day would reduce materially. This canal would make the route to Liverpool 885 miles shorter than the one by the way of New York.

Organization of a Fire Department.

IN connection with "circular No. 63," issued by the Boston Manufacturers' Mutual Fire Insurance Company, we here abstract from the next in order, as the subject is directly related, though not properly included under civil engineering. "Circular No. 63" treats of tests of fire-proofing material.

In "Circular No. 64" suggestions are given to mill-owners as to the organization of an individual fire department among their employees. Mr. Atkinson would officer the fire company as follows:

"Chief of department—agent, or general manager.

"First assistant — superintendent of mills.

"Second assistant chief of department—master mechanic.

"(The number of additional chiefs to depend upon the size of the works and the number of hose companies in the department.)

"Engineer—chief engineer of mills.

"Assistants — assistant engineers of mills."

The first assistant chief acts as a vice-chief. The second assistant has charge of the pipe and hydrant system, making at least two inspections a year. He also makes "weekly inspections of pumps, valves, and all fire apparatus, such as hose, hose-carriages, and all fire tools," making written reports to his chief on appropriate blanks. It is the duty of the engineer to inspect all pumps, and to see that the steam and rotary pumps are always ready for action; his assistants have personal charge of these pumps and operate them during fires. "The department shall be divided into two divisions:

"Division No. 1. Hose Companies.—The number of hose companies shall depend upon the number of hydrants about the works, and the number of men employed. Each company shall consist of a foreman, assistant foreman, hydrant men, and four hose men. The foreman shall have general charge of his company, and act under the direction of the chief and his assistants. The assistant foreman shall assist the foreman in the discharge of his duties, and act in his place in his absence. The hydrant men shall be two in number and it shall be their special duty to couple the hose at the hydrants, and to turn on and off the water. One of these men shall always remain at the hydrant; the other shall assist in handling the hose. Hose or pipe men shall be four in number,—that is, enough to handle two streams. These men should be heavy and strong and well-practised in the method of holding play pipes.

"Hook and Ladder Company.—Where works are large, it is well to have separate hook and ladder companies, composed of men three to six in number, who shall take charge of all ladders, erect the same, and act as assistants in handling the hose.

"Division No. 2.—This division shall consist of the overseers in the mills, their second hands and assistants, being composed wholly of inside men. They shall take charge of all the apparatus inside of the mill, acting under the direction of the overseer, and also shall act as a protective department. Each overseer shall see that all fire apparatus of every description in

the rooms in his charge and in the towers adjoining the same is in good order ready for immediate use. In time of fire, it shall be the duty of the overseers and their assistants to remain in their rooms, to see that windows, fire doors, shutters, etc., are closed, and to do everything in their power to keep the fire from entering their departments, by the use of fire pails, small hose streams, etc. In the room where the fire occurs the hydrants and hose shall be under the charge of the overseer, until the arrival of the regular men of Division 1, who will then take charge of the same. It shall also be the duty of men belonging to Division 2 to do all that they can, under the direction of the overseer, to protect the stock and machinery from damage by water by covering the same with blankets or any other waterproof material which may be at hand. In the card room the laps themselves may be used to protect the card clothing.

"Selection of Men.—In the selection of men for Division No. 1, preference shall be given first to the skilled mechanics, second to the yard hands, third to men employed in the dyehouse, if there is one.

"Suggestions for Drilling the Men in the Use of the Apparatus.—Regular meetings of the department shall be held at least once in two weeks. It is suggested that they be held on Saturday. At these meetings the men shall be thoroughly drilled in the use of the apparatus in such a manner as will accustom them to quickly couple up the hose and bring the streams into operation. They should be accustomed to handling the hose on ladders and carrying the same up on to the buildings. By doing this the men soon come to have confidence in themselves, and, when a fire occurs, they will work more readily and without the excitement that they would be under if they did not have this drill. It is of the utmost importance that the watchmen, who during the night time constitute the whole force on the premises, should be especially drilled in the use of the apparatus and instructed what to do in case of fire. Whether or not any payment should be made to the members of the fire brigade is left to the decision of each manager. It has an excellent influence to make a small payment, and to make it in some senses a privilege to belong to the department by giving an annual outing and holiday to members."

Specifications for Brick Paving.

OWING to the growth of the paving-brick industry in the central States, and the large amount of money expended by municipal authorities, it has become necessary to closely define the conditions under which contracts are let in order to do justice to competing contractors. The town of Peoria, Illinois, according to *The Engineering News* (Nov. 21), has drawn up an unusually complete set of street-paving specifications for this year as follows:

"The foundation is to be 6 in. of concrete, composed of 1 part natural cement, 1½ parts sharp sand, and 4 parts broken stone concrete, covered with a 2½-in. cushion of sand. The size of the bricks is to be 2½×4×8 in., or 3×4×9 in., and they are required to withstand the following tests: (1) a transverse test flatwise, in which they shall show a modulus of rupture of 2,200 lbs. per sq. in.; (2) an absorption test, in which, after 48 hours' immersion, they shall show an absorption of not more than 2 per cent. of their own weight; (3) an abrasion test, in which 12 bricks are placed in a cylindrical rattler, 24 in. by 3 ft., with 300 lbs. of smoothly-worn scrap iron, in pieces varying from ¼ lb. to 5 lbs. in weight, and revolved one hour at 15 revolutions per minute, after which the loss by weight for the smaller brick is to be not more than 9 per cent. and of the larger brick not more than 7 per cent. The cement is to be tested for fineness, time of setting, soundness, and tensile strength. In the pavement the bricks are to be set on edge in rows running transversely across the street, except at street intersections, where the rows shall make an angle of 45 deg. with the curb lines. After laying, the bricks are to be settled by a roller weighing not less than 250 lbs. per lin. in., or by tamping by a 60-lb. rammer on a 2×12-in.×12-ft. plank. The joints are to be filled with sand."

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Current Leading Articles on Civil Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Bridges.

†2517. The Best Substructure for Small Highway Steel Bridges. John H. Burnham (Advocating stone that will withstand frost, but as this is scarce in Illinois, steel I beam posts on mud sills with plank or iron backing are sometimes used but are not as good as stone for abutments, though cheaper). 10th An Rept of Ill Soc of Eng & Surv. 600 w.

2555.—$1.50. What Is the Life of an Iron Railroad Bridge? J. E. Greiner (Read before the Am. Soc. of Civ. Eng. with discussion and correspondence. An interesting discussion on the factors necessary to consider in bridge design, and the effect of increased weight and speed of railroad equipment on bridges already up; a table of safe allowable unit stresses proposed for use in new designs. Considerable information is brought out in the discussion). Trans Am Soc Civ Eng–Oct. 20500 w.

2577. Steel Arch Highway Bridge, Lansing, Mich. Ill. (A bridge carrying Michigan Ave. over the Grand River, composed of two 110-ft. arched girder spans, supporting a roadway 115½-ft. in width over all. The ends of the 4 ft. girder arches are pin connected; the bridge is noteworthy by reason of its unusual width). Eng News–Nov. 14. 300 w.

2586. Union Pacific Railroad Bridge Specifications (These specifications for 1895 make the live load equal to a uniform load including the effects of impact, and include qualification of material and workmanship, construction and drawings. The article gives extracts from the more important provisions). Eng Rec–Nov. 16. 1500 w.

2591. Temporary Trestles over Washouts (Abstract from a committee report to the Assn. of Supts. of Bridges and Buildings, with details of methods considered best in opening the road to traffic). R R Gaz–Nov. 15. 1200 w.

2726. Phoenix Bridge Company Specifications (The extracts given indicate that the specifications are full and valuable as there is no point in common practice which is left in doubt in either railway or highway bridges). Eng Rec–Nov. 23. 1800 w.

2789. A Bridge Over the Danube at Cernavoda. Ill. (A five span bridge 2460 feet long, costing $1,567,456 for the main bridge). R R Gaz–Nov. 29. 1000 w.

2838 The Spring Avenue Bridge, Troy, N. Y. (Detailed illustrated description). Eng Rec–Nov. 30. 2000 w.

2970. The Minneapolis Arch Bridge (General elevation, and sections, details of viaduct, approach spans, arch trusses and tower). Eng Rec–Dec 7. 700 w.

Canals, Rivers and Harbors.

†2515. Location and Alignment of Drainage Districts. D. L. Braucher (Maintaining that easy curves and long tangents are of the greatest importance in locating a drainage channel). 10th An Rept of Ill Soc of Eng & Surv. 700 w.

*2524. The Nicaragua Canal. Archibald Colquhoun (An address at the London Chamber of Commerce stating that the cost of the canal will aggregate 20 million dollars with a probable annual return of 9 %. He discourses at length on the immense advantage it will be to the trade of Eastern United States and the leverage it will give them in competition with English trade in the East). Ind & Ir–Nov. 1. 700 w.

*2527. Navigation of the River Parrett—Proposed Ship Canal to Bridgwater. Ill. E. Duncan Stoney (A prize competition design fully illustrated by drawings of contours, sections and structural details, with itemized cost sheet. A well prepared article). Eng, Lond–Nov. 1. 2600 w.

*2571. Canal Boat Towing Test on the Erie Canal. Ill. (Report of the test at Tonawanda. By the side of the tow-path are two cables; the upper 1¼ in. cable is 16 ft. from the ground and supports the motor, the smaller ⅝ in. cable is wound around the hauling drum of the motor and carries the return current. Five loaded boats were towed at the rate of 4.7 miles per hour. It is estimated that this method will reduce the cost 82% over mules, and 55 % over steam. The test was under official supervision). St Ry Rev–Nov. 15. 1300 w.

*2573. Cawley System of Canal Haulage. Ill. (The boats are drawn by electric motors running on elevated tracks beside the canal. The motors run on two tracks, one above the other, so that there is no interference in passing each other. They are controlled from the boat). St Ry Rev–Nov. 15. 150 w.

2698. Transportation on the Pennsylvania Canal (Canal transportation of freight and passengers in the forties across the Allegheny mountains to Pittsburg, with illustrations of the boats used). Am Mfr & Ir Wld–Nov. 22. 500 w.

2806. The Report of the Nicaragua Canal Commission (An alleged abstract of the report as published by the *N. Y. Herald*. The commission report a necessary expenditure of double that estimated by the company, and bring other facts to light which discourage the scheme). Eng News–Nov. 28. 2000 w.

Hydraulics.

*2465. Location and Construction of Dams. Ill. J. B. Johnson (Showing the means of securing imperviousness and stability in dam-building). Eng Mag–Jan. 4500 w.

2758.—$1.50. The Discharge of the Mississippi River. Map. William Starling (A very exhaustive paper showing the great difficulty of obtaining uniform results. The work in its general principles, the use of formula, and system of observations is given in full; also the results of previous work). Trans Am Soc of Civ Eng–Nov. 50000 w.

We supply copies of these articles. See introductory.

2929. Water Power—Its Generation and Transmission. Samuel Webber (This paper, read before the Am. Soc. of Mech. Eng., contains facts regarding rainfall, drainage, efficiency of turbines, and cost of water power plants). Ir Age-Dec. 5. 700 w.

Irrigation.

*2466. The Law of Water and Modern Irrigation. Richard J. Hinton (Reviewing the United States Circuit Court decision that the California laws creating municipal irrigation distrists are unconstitutional, and favoring State ownership of water). Eng Mag-Jan-3800 w.

2580. Artificial Stone and Concrete Work. Ill. (A drainage canal twelve miles long, with a section five feet wide at the bottom, 12 ft. at the top, and 5-ft. deep. The ditch is lined with cement which is said to have doubled the discharge. Three half tones illustrates the canal finished and under construction). Min & Sci Pr-Nov. 9. 200 w.

Miscellany.

*2478. The Blackwall Tunnel (An editorial account of a visit to the recently completed subaqueous portion of this important work. Remarks followed by a description of the construction). Builder-Nov. 2. 2500 w.

†2513. Photography for Engineers. John W. Alvord (Giving the experience, amusing and instructive, of an engineer with a camera, and how he uses it to illustrate his reports, etc). 10th An Rept of Ill Soc of Eng & Surv. 1800 w.

†2514. The Value of Marked Trees in Fixing of Survey, etc. I. H. Serviss (Showing that marked trees are the best witnesses as to the location, and how the date of survey may be determined by cutting out the mark and counting the rings of growth). 10th An Rept of Ill Soc of Eng & Surv. 400 w.

†2516. Easement Curves in the Race Track. D. L. Braucher (A plan for an oval race course with mathematical calculations and cut illustrating manner of laying out). 10th An Rept of Ill Soc of Eng & Surv. 1100 w.

2536. The Maintenance of Macadamized Roads. Thomas Aitken (A paper read before the Inst. of Civ. Eng's. on the use of machinery for repairing roads in the county of Fife, Scotland. Stone breaking, rolling, and cleaning the surface are fully described). Eng Rec-Nov. 9. 2500 w.

2547. Concrete Construction. Henry A. Gray (Giving the results of observations of English practice, with many figures relating to mixtures, etc., and methods of using). Can Eng-Nov. Serial. 1st part. 2200 w.

*2549. The Blackwall Tunnel (Account of the inauguration ceremony, and a description of a tunnel 27-ft. in external diameter, and 6200-ft. long, under the Thames, constructed under unusual difficulties and at a cost of over £1,000,000). Trans-Nov. 1. 2700 w.

*2550. Dock Gates and Pumping Machinery (An interview with a contractor as to the more recent appliances in use). Trans-Nov. 1. 2000 w.

2553.—$1.50. Topography on the Survey of the Mexico-United States Boundary. J. L. Van Ornum (Read at the Annual Convention of the American Soc. of Civ. Eng., with discussion and correspondence. A paper written to show the adaptability of known surveying methods, especially in stadia work, and giving a general review of the methods adopted in the Boundary survey). Trans Am Soc Civ Eng-Oct. 8500 w.

*2656. Crushing Tests of Building Stone (A table compiled from the most authoritative sources, giving the crushing weight in lbs. per sq. in. and tons per sq ft. of stones from various localities). Stone-Nov. 600 w.

2686. Protection of Piles Against the Teredo. Ill. (The piles of a railway trestle were encased in vitrified culvert pipe, the joints being made with a pitch and sand cement, and the space inside filled in with sand and gravel. The plan has been very successful). Ry Rev-Nov. 16. 800 w.

2695. The Subway in Boston (Extract from report of Howard A. Carson, under the caption "Studies for Cross Sections," also regarding the ventilation of the subway, from report of S. Homer Woodbridge). W Elec-Nov. 23. 2700 w.

*2743. The Institution of Civil Engineers (Editorial comment on an extremely interesting lecture by Sir Benjamin Baker on the occasion of his occupying the presidential chair of the Institute of Civil Engineers. He shows in what ways a scientific society can be a material factor in the progress of the engineering profession, and states the specific ways in which such results may be obtained). Engng-Nov. 15. 2800 w.

2753. The Illinois Central and the Lake Front. Ill. (The Chicago terminal improvements, which will give one of the finest terminal arrangements in the country when completed. The total cost to be about $1,000,000). Ry Rev-Nov. 23. 3000 w.

*2764. Presidential Address of Sir Benjamin Baker (Delivered before the Inst. of Civ. Engs. The ideas are interesting both historically and on account of their practical tendency. Editorial comment). Eng, Lond-Nov. 15. Serial. 1st part. 8600 w.

*2766. Presidential Address of Mr. Archibald Denny (Delivered before the Inst. of Junior Engs. upon the apprentice system, and the handling of young men in the drawing office, the work, and in business positions). Eng, Lond-Nov. 15. 5500 w.

2790. Some Results of an Engineering Education (Editorial. Defining the engineer as "the flower of the human race," and stating that there is no training which makes a man more useful or successful). R R Gaz-Nov. 29. 800 w.

*2845. Remarks on Subaqueous Tunnelling by Shield and Compressed Air. J. H. Greathead (A paper read before the Inst. of Civ. Engs. describing the tunnel under the Thames, 73 feet below high water, and 10 ft. 6 in. in diameter) Col Guard-Nov. 22. 1800 w.

DOMESTIC ENGINEERING

The Poisonous Qualities of Acetylene.

THE extensive adoption of acetylene for illumination, should this come to pass, will involve some new dangers to life and property. Nature allows man to utilize no one of her hidden resources without the risk of penalties for inadvertence or lack of due caution. The danger of the formation of explosive compounds when the acetylene gas is brought into contact with copper or alloys of copper has been noted in this magazine (vol. 9, p. 378). The poisonous qualities of acetylene (also called ethine), which take effect when inhaled pure or mixed with atmospheric air, have now been tested by Dr. W. H. Birchmore, whose experiments (an account of which is communicated by him to *The Electric Engineer*, Nov. 13) render it certain that a small portion of it mingled with air will, when inhaled, produce injurious and even deadly effects upon the human organism. The danger of small leaks in a system of piping used to distribute the gas to burners, or in the burners themselves, is obvious.

The first fact claiming attention is that, in an aqueous solution of the gas containing equal volumes of gas and water, the volume of acetylene that will evaporate is notably greater than that of the water vapor simultaneously escaping. It is also proved that the gas will continuously diffuse and escape through the water-seal of an ordinary gas-holder. Dr. Birchmore says:

"Twice in the course of my studies the opportunity occurred to measure the amount that, diffused in the air of the room, would produce distinct headache in the course of a short time, and it was found to be rather unexpectedly large as compared with the product of the imperfect combustion of the ordinary illuminating gases. As stated, the air in the room wherein the experiments were conducted was known to be changed once in an hour. The cubic contents of the room was about five thousand feet, if a proper allowance is made for the space occupied by properties. The amount of gas diffused was two and one-half cubic feet, or one in ten thousand. Within twenty minutes a decided headache was noticed, with a sense of dizziness, that was a sufficient warning to get into fresh air. The second time, the experiment was made of remaining until the sight was slightly affected; this proved very foolish, for, in the course of an hour after leaving the room, respiratory difficulty appeared, and, in the course of a few hours, nausea, and a prostration and sense of the impossibility of exertion that forced me to remain in bed all the next day. The effects were not those of sleep, but the exact counterparts of the subjective effects of the ether narcosis,—hallucination and all. Three days afterwards the heart respiration ratio was so sensitive that an attempt to walk rapidly across the Brooklyn bridge produced such a feeling of exhaustion as to compel rest.

"The important fact in this connection is that a man well acquainted with the smell of acetylene was twice in the room in the course of this experiment, and, on question afterward, said that he did not notice anything peculiar about it, and certainly had not noticed the 'smell of the acetylene.' It is possible that the very familiarity with this smell may have blunted his perception, but at the same time it may be urged that he would have been doubly sensitive, knowing the danger involved in breathing it. It is, therefore, safe to say that as much as one part in ten thousand may be diffused in the air of a room without being detected by the sense of smell in some persons, and that this amount can produce dangerous effects.

"Can this dose of one in ten thousand be considered fatal, and, if so, how long a time is required to produce this effect?

"Up to date there is no record of any attempt at 'suicide with acetylene for the

sake of science,' but an experiment on a guinea pig gave the following results:

"Alarmed at my own experience, it seemed a good thing to know if a reasonable limit could be set to this sort of a thing; so a large, healthy guinea pig was confined in a tight box, containing two hundred and sixteen cubic feet. Experiment showed that confinement in this box under ordinary conditions for a period of forty-eight hours had no effect on his health, appetite, or spirits, although the air must have been much deprived of its oxygen, by the measure it sank below the proper respiratory limit for human beings; therefore I judged that any error that might get in would be on the safe side. At ten o'clock in the forenoon I drew out thirty-four cubic inches of air, and substituted ethine; in about ten minutes my prisoner was evidently uneasy, and in half an hour was hid away under the straw,—the usual habit of guinea pigs when in distress. They do not run about, as do some animals, and, when, at four o'clock, I opened the box, my pig was dead, and his blood had lost the power of absorbing oxygen almost as if killed by cyanogen. As the guinea pig is a rather hardy little beast under this sort of treatment usually, it seems certain that a man would or could be fatally injured by breathing a mixture of one part of ethine in ten thousand of air for six hours."

It is evident from these experiments that acetylene operates as an active and insidious poison, when taken into the circulation through the lungs, and that, while intermingled with air to an extent imperceptible to the sense of smell, it may produce very injurious effects. These facts will have to be very carefully considered and dealt with before acetylene can take any important place among domestic illuminants.

M. GREHAUT gives in *Comptes Rendus* an account of some experiments with acetylene which did not indicate so great toxicity as is attributed to it by Dr. Birchmore. M. Grehaut experimented with mixtures containing 20, 40, and 79 per cent. of acetylene (the mixtures in all cases having 20.8 per cent. of oxygen as atmospheric air); and he found that it is poisonous if inhaled in large quantities,—between 40 and 79 per cent. He asserts, however, that it is much less deleterious than coal gas. Mixed with oxygen, it is highly explosive. Referring to these experiments, M. Berthelot says the toxicity of acetylene would be much greater than it is, if it were mixed with carbonic oxid or hydrocyanic acid.

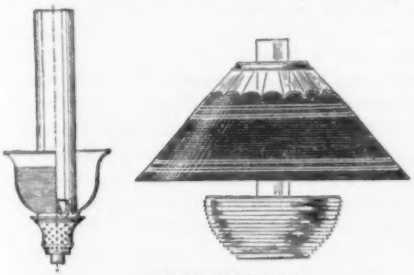
Doubtless others will be led to experiment upon the qualities of this gas, and there will not much longer be any uncertainty or difference of opinion as to their quantitative effect upon the human system. The question should be thoroughly settled in advance of the introduction of the gas for illuminating purposes, even at the expense of the lives of sundry rabbits and guinea pigs.

A New Lamp Globe.

A NEW French invention by Mr. M. Fredureau, which he calls a "*globe diffuseur*," has crossed the English channel, has been placed on sale in London, and is highly recommended by *The Gas World* (Nov. 16), the editor of which, having used one in connection with a Welsbach gas burner, asserts that the result is very pleasing and agreeable. The journal named describes the invention, which has been tested by Professor Sylvanus Thompson with the following results. Professor Thompson "found that, while a naked incandescent electric lamp gave only 8 c. p. in the downward direction, it gave 17.5 c. p. when fitted with a shade, and 34 c. p. when both a globe and a shade were used. As Professor Thompson's test indicates that the globe can double the efficiency, the shade can be dispensed with for most practical purposes."

The Gas World says the globes have a shape according with the laws of geometrical optics. "The inner surface of the globe is smooth, while the outer surface is provided with prismatic rings concentric with the center of the globe. If a section of these rings is examined, it is perceived that the upper rim of each ring is a segment of a paraboloid, and that the under

rim is a plane. These different paraboloids have the same center as the globe, and that center for a focus. The result of this mode of construction is that the luminous rays coming from the focus are reflected and split on the upper surface of each ring, and return from the under surface parallel with the axis of the globe; the greater number of these rays illumine the region under the lamp, but a small quantity are reflected by the lower ring and are diffused, while a small portion is reflected into the interior of the globe. Those rays reflected into the interior of the globe are the most refrangible ones,—the ones most trying to the eyes. The globe can be used with either arc or incandescent electric lights, or incandescent or argand gas lights, or with circular oil flames; but the necessity of proper



GLOBE DIFFUSEUR

centering does not permit of its being applied with full effect to flat flames. Seen with the Welsbach light, the effect is decidedly striking; the mantle is apparently considerably lengthened, and the amount of light thrown downward is, as we have said, vastly increased, while the whole appearance is soft and pleasant to the eye. The principles that have been so successfully applied to the *globes diffuseurs* can be equally applied to projectors, which can be so placed as to project horizontally or vertically. The globes, which are but little heavier than plain glass globes, are made in a variety of sizes and shapes. The accompanying cuts will give a general idea of their appearance." Probably these globes will soon find their way into the American market.

Professor Thompson says, further, that he has found the globes effective in concentrating the light in the desired direction, as indicated by photometric measurements. "In the case of arc lamps burning with continuous currents, it is well known that the usual mode in which they cast their light is an irregular distribution, having its maximum at about forty-five degrees, and having a deep shadow immediately beneath the lamp. When provided with a diffusing globe, the same arc lamp now gave its maximum illumination directly downwards, the light in the forty-five degrees direction being much reduced."

There is little doubt of the value of this invention for desk workers, draughtsmen, and those required to perform any kind of manual work by artificial light.

Air Gas and Incandescent Lighting.

THE following description of this innovation is an abstract of an article in *The Gas World*.

The system has nothing to distinguish it from hundreds of systems that have lived, and died, before it, except this one feature, —that the carburation of the air is carried only to that point which gives a non-luminous flame. But it may well be that this difference, simple as it appears, may mean the difference between failure and success. Effort has been directed to combining the use of air gas with the employment of the incandescent burner. The system supplies to the air only sufficient liquid hydrocarbon to produce a non-luminous flame by means of a simple automatic arrangement which is thoroughly under control. One result of this small addition of hydrocarbon is that there is no condensation in the carburetter or in the connecting pipes; and another is that the Bunsen burner is not necessary for the proper combustion of the gas. The gas can be burned as well in a closed circular burner as in an ordinary batswing burner; for, as it contains within itself the oxygen necessary to combustion, no special effort is required to bring the oxygen to the point of ignition. The gas so made and so burned appears to work well with the incandescent mantle.

A burner is employed that combines the advantages of both incandescence and re-

generation. This burner can be fitted into an ordinary regenerative lamp of the inverted type, or it may be placed in a pear-shaped globe, such as the electric light has made familiar. By the apparatus air can be carburetted equally well by coal gas,—that is to say, the gas and air can be mixed before reaching the burner, and not at the burner, as is the present practice, enabling a more regular and thorough mixture to be obtained.

More About Electric Heating.

IN a paper read by Mr. J. Chester Wilson (April 30) before the Engineers' Club of Philadelphia, and reprinted in the *American Architect*, the author, after discussing the laws which govern the generation of heat in conductors, quotes the *Electrical Engineer* as asserting that the commercial efficiency of the coal cooking-range is as low as between 3 and 6 per cent. He also quotes a statement made before the London Society of Engineers, putting the average efficiency of a coal range—alleged to have been determined by actual experiment—as low as 4 per cent., and showing that only about 1 lb. of coal in 27 is actually utilized in kitchen ranges. He then states that in the electrical kitchen, in New York, on an 11 weeks' trial with electricity furnished at 5 cents per h. p., an average of ninety-seven persons were served at an average cost of 25 cts. each for the heat.

If these statements are absolutely correct, there seems to be some reason to hope that electric heating may be made available for domestic cooking. But, if the heat of ranges is estimated as wholly applied to cooking, the statement is not fair to the ranges. In cold weather a large part of the heat from a range, as ordinarily used, is utilized in house warming. In summer, the use of gas fuel for culinary purposes is largely increasing, and it will ultimately supplant coal for summer use in private establishments. So, to be fair in such a comparison, it should be made for coal ranges in winter, and for gas ranges in summer, and the heat value of the range for house warming in winter should be taken into account.

Fires from Steam Pipes.

IN line with what was said in this department for December in relation to fires generated by heating pipes, *Machinery* (London) gives an explanation of the way in which such fires occur, and a reason why they are usually nocturnal. It says that "neither ordinary live steam nor superheated steam will heat a pipe thick and strong enough to convey it to a degree sufficient to produce a fire on wood, however dry. It will not even set charcoal aglow or in a blaze. But dry charcoal, when the heat is removed from it, being nearly pure carbon, will absorb oxygen from the air under favorable conditions so rapidly as to produce active combustion,—that is, a glow or a blaze. The process of the origin of a fire from a steam pipe will, in course of time, char, or, as the chemists say, carbonize, wood in contact or close to it. When this charring process extends to any depth in the wood, it presents a surface full of fissures and cracks, thus exposing a large section to the air. This process of charring drives the oxygen out of the charred portion, and keeps it out while the heat is kept up. When the heat is removed, the charcoal reabsorbs oxygen from the air, and, if the action is rapid enough, in a dry atmosphere combustion is the result. This explains why fires from steam pipes occur after the pipes have cooled.

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Heating and Ventilation.

2537. Hot-Water Heating in a Country Residence. Ill. (The residence in which this plant is installed is that of Mr. John Jacob Astor, at Rhinecliff, N. Y. It is 84 × 88 ft. in plan and its situation is somewhat more than usually exposed). Eng Rec-Nov. 9. 1800 w.

*2552. The Heating of Buildings. George Hill (A general essay on the subject of warming buildings, covering the principal classes of buildings and their special requirements, and also the principal varieties of apparatus and appliances used for the purpose, with some practical suggestions relating to their successful install-

We supply copies of these articles. See introductory

ment and operation). Arch Rec–Oct.-Dec. 5000 w.

2636. Boiler Explosions. Ill. R. C. Carpenter (A general discussion of the subject with examples of explosions of steam, and hot-water boiler explosions in Canada and the United States, which, however, are stated to be very rare in proportion to the large number in use). Heat & Ven–Nov. 15. 1300 w.

2729. Hot-Water Heating of a Residence (Illustrated detailed description giving plans of floors, and particulars of a design in hot-water heating apparatus containing some unusual features). Eng Rec–Nov. 23. 450 w.

2730. Heating a Greenhouse (Illustrated detailed description of an unusual method of warming a greenhouse, now attached to a residence in West Superior, Wis., which was also one of the exhibits at the World's Fair, in Chicago). Eng Rec–Nov. 23. 200 w.

*2762. A Study of the Heating and Ventilating Plants in the Suffolk County Court House and the Massachusetts State House, Boston. Ill. Percy N. Kenway (A comparison of results in two buildings very nearly alike in size, exposure, and conditions of use, but supplied with radically different heating plants. A very interesting and instructive study in the art of heating and ventilation). Jour of Assn of Engng Soc–Oct. 5300.

2842. The Ventilation of Railway Coaches (Present and possible ventilation of railway coaches discussed from a mechanical standpoint). Eng Rec–Nov 30. 2500 w.

2968. A Complex Job of Steam Heating. Ill. (Reprinted from the *Plumbers' Trade Journal*. Describes a complicated job of steam fitting wherein a new set of appliances was joined to an old one, in a college building). San Plumb–Dec. 1. 500 w.

2971. The Heating and Ventilation of the German Theatre, Chicago (Illustrated detailed description with plans of basement and each story. A good study in heating). Eng Rec–Dec. 7. 2300 w.

Landscape Gardening.

2603. Save the Palisades. From the N. Y. Times (On the destruction caused by quarrymen and the necessity of speedy action if the beauty of the palisades is to be preserved). Forester–Nov. 1. 1300 w.

2645. Seasonable Work Among the Trees (Editorial remarks regarding the planting of trees and the cutting, trimming, &c). Gar & For–Nov. 20. 1200 w.

2781. Schools of Horticulture (Editorial comment favorable to these schools, with an account of the latest meeting at Jamestown, N. Y). Gar & For–Nov. 27. 1100 w.

Plumbing and Gas Fitting.

2474. Dry Insulator for the Detection of Leakages of Gas (Describes and illustrates a new apparatus for detection and location of leaks in gas-pipes). Sci Am Sup–Nov. 9. 600 w.

2589. Some Plumbing Details in the residence of John J. Astor. Ill. (An instructive description, especially to those who wish to familarize themselves with the best examples of high class sanitary plumbing). Eng Rec–Nov. 16. Serial. 1st part. 2000 w.

*2702. Fredureau's Light-Diffusing Globes (Illustrated description of these globes and explanation of their operation, their configuration being claimed to strictly accord with laws of geometrical optics). Gas Wld–Nov. 16. 700 w.

*2708. Possibility of Simple and Safe House Plumbing. Herbert J. Bowman (Paper read at the annual meeting of Medical Health Officers for Ontario. An examination of statutory plumbing regulations compiled in 1884, concluding that some changes and additions will be required when the statutes are revised). Can Arch–Nov. 2500 w.

2967. Plumbing Fixtures of the Past and Present (Proposes to describe, with illustrations, the principal plumbing fixtures and appliances of past and present time. The first part treats of water closet, bath and lavatory fixtures). San Plumb–Dec. 1. Serial. 1st part. 900 w.

*2972. Sanitary Appliances and the Principles of Ventilation. A. Wynter Blyth (The fourth of a series of lectures at Carpenters' Hall. Dealing chiefly with water closet construction and ventilation, with some remarks on dwelling ventilation). Arch, Lond–Nov. 29. 3000 w.

*2977. Interview with M. Bandsept (Reported for this publication. An exposition by the inventor of the advantages of the Bandsept burner now attracting considerable attention abroad). Gas Wld–Nov. 30. 1300 w.

Miscellany.

2539. Air Gas and Incandescent Lighting (This is a new system of lighting in which a non-luminous gas that will burn with sufficient heat is rendered luminous by bringing it into contact with a mantle that is rendered incandescent. Air gas, that is, air charged with hydrocarbon vapor only to a point that will cause it to burn without luminosity is used). Am Mfr & Ir Wld–Nov. 8. 1000 w.

2545. The Physiological Action of Acetylene. W. H. Birchmore (General conclusions deduced from experiments bearing upon the amount of the gas that can be diffused in the air of a room without perception by the senses; the amount required to produce headache; and the amount and time required to produce a fatal effect). Elec Eng–Nov. 13. 1200 w.

2688. Chimneys' Science (Relates some very instructive experience with chimneys and with stoves that would not work properly until they were properly connected with chimney flues). Met Work–Nov. 23. 2200 w.

*2770. On the Alleged Escape of Carbonic Oxide and Unconsumed Carbon from Coal-Gas Flames. Lewis T. Wright (A denial that danger or injury results in the ordinary use of coal gas either for lighting or heating as a result of unconsumed gases. Also contains some criticisims upon Mr. W. Thomson's experiments which appear to indicate that products of imperfect combustion may be present). Jour Gas Lgt–Nov. 19. 2500 w.

2972. The Requirement of a Bond from an Engineer (An able letter, written by Prof. S. Horner Woodbridge to the chairman of the committee of public property of Boston, declining to give a bond and stating reasons). Eng Rec–Dec. 7. 2000 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

Storage Batteries Score Victories.

MANY able electricians, of whom the late Mr. Franklin Pope (at the time of his death editor of this department) was one, have regarded the storage battery as not possessing much value, except for a limited field of special applications. That it ever could compete successfully with the trolley system as a means of supplying electric motors for propulsion of tramcars was regarded by Mr. Pope as hardly within the limits of possibility, and entirely without the limits of probability. That the grounds for doubt appeared to such doubters sufficient to justify their expressed opinion is warrant in itself for the doubts of smaller men. But now and then some facts crop out which *prima facie* seem to indicate that, after all, they may have been mistaken. For example, Mr. Maurice Barnett in *Western Electrician* (Nov. 9) quotes an announcement from the *Kolnische Zeitung* to the effect that the trolley system in Hanover is to be discarded, and the twenty-eight cars hitherto propelled by that system are to be fitted and propelled by storage batteries.

He further states that, "since the announcement in the *Kolnische Zeitung*, news has been received that the Dresden Tramway Company and the Hague Tramway Maatschappy have likewise decided in favor of accumulator traction. Inasmuch as no less important a company than the Tudor Storage Battery company is making the installation, it is not at all too optimistic to believe in the ultimate success of the storage-battery cars about to be operated in the places named."

Upon these items of news, assumed to be reliable, Mr. Barnett significantly comments as follows:

"Up to the present time the engineers of the overhead system have had matters pretty much their own way. Occasionally a statement of results (coming in all probability from interested sources) bearing upon the success obtained with the open conduit has caused a commotion in the trolley ranks, but, save for that, the erection of poles has gone merrily on, and the manufacturers of trolley machinery have had no complaints to offer on the ground of lack of orders. The last two months, however, have seen the beginning of a mighty change. To-day the trolley is considered to have been merely coincident with the evolution of the modern passenger railway, and its usefulness in the future, at least in cities, is not likely to be greatly overestimated. E. H. Johnson, who, with Lieutenant F. J. Sprague, was the pioneer in working out the trolley method of electric transportation, writing in the *Electrical Engineer* under date of October 9, sounds the doom of the overhead line, at least in cities and towns. The reason for this belief is to be found in the objection to overhead construction, and, secondly, in the fact that greater economies are possible in the newly-projected closed-conduit system by reason of the fact that higher voltage may be maintained than is practicable in trolley systems. This criticism, emanating from one of the parents of the overhead wire system, may be considered to have some weight. Mr. Johnson also proceeds to pay his respects to the open conduit system, anent the great ado made by the Metropolitan Traction company of New York, 'over the practical success of their $150,000 per mile open-conduit system,' by saying: 'It was neither scientific nor business-like to place the electrical conductors in a sewer and then expend hundreds of thousands of dollars to secure drainage.' This represents the view that is at present held respecting the open-conduit electric system. Surely the friends of the electric accumulator can take hope in the discomfiture of their rivals."

Mr. Barnett further expresses the view

that the contest for supremacy in propulsion is now to be waged between the closed-conduit system and the storage-battery systems, and he predicts that within six months the critics who have been sneering incredulously at the storage-battery experiments now in progress on the Madison avenue line, in New York city, may be obliged to reverse their conclusions. Perhaps. Time is the arbiter of most disputes of this sort. We shall see. Meantime, there is something more to be said on the storage-battery side of the question, and Mr. Barnett says it. He points to the fact that in the power plant between Zurich and Hirslanden, Switzerland, where power is delivered from the dynamo under constant load, and accumulators are used to supplement power so delivered, a saving of $2500 per year on an investment of $7400 for the installment of the accumulators has been effected. This is an extremely satisfactory profit on the investment.

Again, it is asserted that in Germany and Austria eighty per cent. of all central stations are supplied with storage batteries of a single type, and that to this list may be added fifteen railway power plants and five thousand isolated lighting plants.

Other instances are cited both in this country and abroad, but these are passed by in this review, which we will close by quoting Mr. Barnett's list of the uses to which, in his opinion, the storage battery will be applied, with important results, in light, heat, and power stations.

"(1) As a 'reservoir' in which may be stored up the energy representing the difference between the average and the maximum demand on a generating plant; (2) as a regulator of pressure on circuits subject to fluctuating demands,—increasing the efficiency of the service and diminishing the wear and tear on apparatus; and, (3) as a transformer, to utilize high voltage charging current, and to discharge, when disconnected from generator, at any lower voltage desired.

"One fact that has been demonstrated, and which has the most important bearing on the construction of electric railway power plants, or, for that matter, of most electric light or power stations, is that, in any station which has to meet a fluctuating demand for power, a plant consisting of part steam power and part storage battery is cheaper in first cost than a total steam power plant would be for the same work."

Rating and Behavior of Fuse Wires.

THE fact that, notwithstanding all that has been said and written about it, the thermal cut-out is still alleged to be "one of the most unreliable of the many devices employed on electric circuits," as asserted in a paper having the above title in the *Transactions of the American Institute of Electrical Engineers* for October, amply justifies a return to it, and will continue to justify it as long as the unreliability continues. This paper, prepared conjointly by W. H. Stine, H. E. Gaytes, and C. E. Freeman, starts out with the assertion that, "beyond a few practical details of the device, it is little understood," and that, "as a source of vexation and uncertainty, the fuse is unrivaled."

The authors also assert that an "analysis of the literature of the subject shows that the theory of the thermal cut-out has been thoroughly investigated. The elements entering its action have been carefully studied and incorporated into fairly satisfactory equations. Yet all tests and treatments have shown the thermal cut-out to be subject to such variations that but little of practical value can be deduced from analytical investigations.

"These considerations led the writers to attempt further investigations. The fuse was dealt with as an auxiliary to electrical circuits, and its behavior under such conditions was carefully studied. The work in great part bears on points already treated of, but it was considered best to study the entire subject afresh, and endeavor to present a more or less complete discussion of the behavior of some of the ordinary alloys employed in practice. Naturally the data obtained are voluminous,—in all, some thirteen hundred determinations;" but the authors claim that "great care has been taken to thoroughly check all results."

A description, illustrated by a diagrammatic representation, of the arrangement of the apparatus is comprised in the paper, and this seems to accord with conditions in actual practice. "In all cases the fuse wire was carefully inserted, so as to obtain a uniform pressure of the wire under the screw head without unduly crushing it. The same block was used repeatedly, and little care to keep the terminals clean. This was done to more nearly imitate practical conditions. In only two or three cases out of hundreds of fuses blown did the rupture occur at the contact. Two classes of porcelain cut-outs were employed; one was the open porcelain base 'main line' style, the other the closed porcelain 'K. W.' variety. In the latter, the ten-ampere size has a space of only half an inch between its terminals, though the fuse is suspended out of contact with the porcelain base. This style of block has recently been condemned by the underwriters, and very properly. With the terminals so close together, a fuse blowing at twenty amperes invariably establishes a viscous arc, and the terminals melt with such explosive violence as to frequently shatter the block. Though the open type of block has an added fire risk, the terminals are, as a rule, further apart. A pronounced fault in their construction is that the terminals are let in flush with the surface of the porcelain. Nearly all types of porcelain fuse-blocks merit severe criticism on several points. The terminals are too close together in small sizes, the fuse often resting on the top or base; and their mechanical construction is very poor. Too little attention seems to be given to the proper function of a fuse-block in its design." The timing was done by a stop-watch for periods exceeding one second, and by a chronograph for shorter periods.

Two series of tests were performed, the second series being with the open eight-inch block, and the results were tabulated for each series.

"The testing current passed through the fuse was measured accurately by first passing it through a Weston ammeter. It was thought best to take the resistance of the fuse into account, and adjust the resistance of the ammeter circuit to exactly equal that of the fuse circuit. To accomplish this, a current smaller than the known fusing current was sent through the fuse, and the fall of potential noted on a Weston milli-voltmeter. The current was next switched on the ammeter circuit, and the fall over this was made exactly that over the fuse circuit, by adjusting the compensating carbon rheostat. The fusing current, being accurately measured, was switched over on the fuse. The fusing time was thus accurately ascertained. A non-inductive resistance being employed, the time interval for the current to rise to its full value on the fuse was considered negligible for all but the very shortest periods." Numerous diagrams are also presented in the paper, which by curves illustrate the relative sensitiveness of large and small fuse wires, and show the curves of fusing points and curves of fatigue.

The first series of tests shows the unreliability of porcelain fuse blocks. The commercial rating of the fuse wire is also shown to be imperfect. One conclusion from all the tests is that "the blowing of the fuse is not immediately an electrical act. The current fuses the metal; the cross-section is reduced at some point due to gravity, unequal expansion, or 'sweating'; the heat is, in consequence, intensified at this point, and a globule falls, breaking the circuit and establishing an arc, which soon burns out a length of the fuse. This accounts for the sluggish action of such thermal cut-outs. An ideal fuse would be one that would act at approximately a constant time interval for all currents in excess of its normal. . . . In practice the curves of all thermal cut-outs must be more or less modified hyperbolas. The ideal curve could only be attained, were it possible to eliminate conduction and radiation losses. This is evidently the line to follow in designing a sensitive fuse block." Other practical conclusions are as follows: (1) covered fuses are more sensitive than open ones; (2) fuse wire should be rated for its carrying capacity for the ordinary lengths employed; (3) when fusing a circuit, the distance between the ter-

minals should be considered; (4) on important circuits fuses should be frequently renewed; (5) the inertia of a fuse for high currents must be considered when protecting special devices; (6) fuses should be operated under normal conditions, to insure certainty of results; (7) fuses up to five amperes should be at least one and one-half inches long, half an inch to be added for each increment of five amperes' capacity; (8) round fuse wire should not be employed in excess of thirty amperes capacity, and for higher currents flat ribbons exceeding four inches in length should be employed. These conclusions did not all pass without challenge. Mr. A. E. Kenelly disputed the alleged fact that covered fuses are more sensitive than open ones. If "sensitiveness" applies to the time in which the fuse wire will melt, he maintained, with good reason, that enveloping the wire by a mass of solid material would be simply reinforcing the fuse with additional material to be heated before the fusion could take place. The authors not being present, it was explained by the chairman that the term "covered fuses," as used by them, did not necessarily imply a closely-enveloped wire, but one surrounded by an inclosure of material having an air-space between it and the wire. Mr. Kenelly then admitted that, if that was the meaning of the authors, the conclusion criticised was valid.

Canadian Telegraph Lines.

THE beginning and subsequent progress of telegraphy in Canada, as set forth by Mr. Charles P. Dwight in a paper before the Canadian Electrical Association at the recent Ottawa convention (*The Canadian Engineer*, Oct.), is of sufficient interest to justify an abstract of it in this department.

The first commercial telegraph line in Canada was erected in 1847, between Toronto, Hamilton, St. Catherine's, and Niagara Falls, connecting with a line through to Buffalo, owned by one David Kissick. "The Toronto, Hamilton, Niagara Falls, and St. Catherine's Electro-Magnetic Telegraph Company" was the ponderous title of the organization which constructed the line. The title, however, expressed well the nature and scope of the company's business.

In the same year the Montreal Telegraph Company was organized, with a capital of $60,000, and by the end of the year was operating with 540 miles of wire, 9 offices, and 35 employees, and had transmitted 33,000 messages. In 1847, also, the British North American Electrical Association was formed to connect Quebec with the lower provinces, and ultimately with the Atlantic coast. This line was finally extended to Woodstock, N. B., where a connection was formed with the American Telegraph Company, afterwards absorbed by the Eastern Company. Each of these lines failed financially, and all, together with the line between Quebec and Montreal, were turned over, without charge, to the Montreal Company. In 1848 a line was built from Calais, Me., to St. John, N. B., and this line has now been incorporated into the New Brunswick Electric Telegraph Company, with a capital of $40,000. In 1849 a line was completed between St. George and St. Andrews, and in the following summer a line was constructed connecting St. John with Hampton, Sussex, Salisbury, Dorchester, Sackville, and Amherst, there connecting with the government line in Nova Scotia, built in 1849, thus first telegraphically connecting Halifax with New York.

In 1856 the lines of the New Brunswick Telegraph Company were leased to the American Union Telegraph Company, and some 10 to 12 years later came under the direction of the Western Union Telegraph Company.

The government line between Halifax and Amherst was sold in 1851 to the Nova Scotia Electric Telegraph Company, an organization chartered in March of that year, and which afterwards extended the line from Pictou to Sydney, C. B., and from Halifax to Yarmouth. Upon completion of arrangements for the landing of Atlantic cables in Newfoundland, the lines of the Nova Scotia Company were leased to the American Union Telegraph Company, which purchased the lines outright in 1872. In 1849 was organized the Montreal and Troy Company, which built a

ine the same year from Montreal to the frontier, and thence, *via* Whitehall, to Troy. This company was organized by Ezra and Alonzo Cornell, who also constructed the line, and worked for several years afterwards in connection with the Montreal Company. A. B. Cornell, who, it will be remembered, was afterwards governor of New York State, acted as manager of the company at Montreal for 2 years after the construction of the line. Some years afterwards the section of the line from Whitehall north became the property of the Montreal Telegraph Company, under a compact with the American lines, known as the Six Party Contract, whereby certain divisions of territory were made and allotted to each company.

In 1850 was built a line between Montreal and Bytown. It was afterwards purchased by the Montreal Telegraph Company.

In the year 1852 the Grand Trunk Telegraph Company was organized. After a few years, it was purchased by the Montreal Company for the sum of $11,000. Then sprang up another organization, known as the Provincial Telegraph Company, which built a line over the same route, but it too was soon absorbed by the Montreal Company.

In 1868 was organized the Dominion Telegraph Company, which soon built lines embracing all the important points between Buffalo, Detroit, and Quebec, and whose opposition became more lively as time went on. Rates were reduced, and the outcome promised disaster for all concerned. Therefore, when a proposition was made in 1881 for the consolidation of these conflicting interests, under lease, by the Great North-Western Telegraph Company, considerable satisfaction at the prospect was expressed by all concerned, and a deal on these lines was accordingly put through, and is in effect to-day. The combined mileage of the two companies at the present time, as operated by the Great North-Western Telegraph Company, is 18,000 miles of poles, and 40,000 miles of wire, with about 1800 offices throughout Ontario, Quebec, New Brunswick, Manitoba, and New York State.

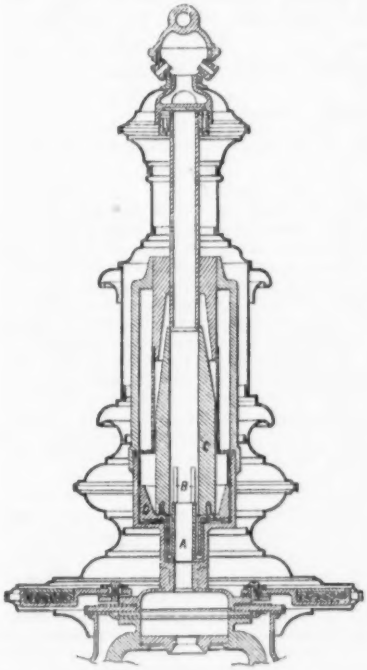
The total amount of capital invested in Canadian telegraphs may be roughly estimated at between $6,000,000 and $7,000,000, and the total wire mileage at about 75,000.

The Jandus Arc Lamp.

THIS is a new form of arc lamp, which, it is claimed, very materially increases the life of the carbons, and which is described in *Engineering* (Nov. 1). The celebrated electrician, Mr. Preece, has estimated the cost of carbons to be one-half the total cost of electric lighting in streets. A reduction of this consumption to any material extent will, therefore, result in a notable economy. The following is an abstract of the article referred to.

By completely inclosing his carbons in an air-tight globe, Mr. Jandus has increased the life of his positive carbon to such an extent that but ten inches or so of a half-inch carbon are burned in the course of two hundred hours, while at the same time the negative carbon wastes only about one inch. This slow consumption has other advantages, since it has allowed the mechanism of the lamp to be much simplified. No feed at all is given to the negative carbon, which is held in a fixed support. The device for feeding the positive carbon is shown in the engraving. The rod passes up the central tube, *A*, and is gripped by four gripping rings which pass through slots in the armature, *C*, two of which are shown at *B B*. The inner edges of these rings press against the carbon, while their outer edges rest on a conical headpiece, *D*, bolted to the armature, as shown. As long as the armature is held up by the attraction of the magnetizing coil, which is not shown in the engraving, the carbon is gripped with absolute firmness; but, if the armature falls, the rings come into contact with the upper edge of the tube A, and are raised so as to release the carbon, which then falls and reëstablishes the normal arc. The magnetizing coil is inclosed in a cast-iron case, and is provided with a conical pole-piece, and the top of the armature is also conical. In this way a very even pull is maintained through a wide range. About a pound and a half

of wire are used in the magnetizing coil, the pull being seventy-three ounces. The contact for the upper carbon is obtained partly through the gripping rings already described, but mainly through a special contact-maker placed in the recess. This contact-maker consists of a large number of brass rings placed vertically around the carbon, and resting against it with their inner edges, the arrangement being to some extent similar to the gripping rings already described. The contact is, however, very



JANDUS ARC LAMP.

light, but, as a large number of these rings are used, there is no trouble from sparking, even in the case of heavy currents. The arc is formed, in the first place, inside a small glass globe, which is not air-tight; but this globe is enclosed in a second larger globe, which is fitted with a valve opening outwards only. When the arc is struck, all oxygen inside the globe is rapidly burned up, and, as the gases inside expand from heat, most of them are expelled into the outer air through the valve already mentioned, leaving the arc to burn in an inert atmosphere. A long arc is used, the electromotive force being 75 volts, and the current from 3½ to 6 amperes. The all-round light is stated to be the same as in an ordinary type lamp taking the same energy.

The first cost of the lamp is not named, but, if, without sacrifice of illuminating power, the durability of the carbons can be increased as much as is stated, then, though this cost might exceed several times that of the ordinary arc lamp, the invention would be a great advance in the art.

Commenting upon the claims made for this lamp, *The Electrician* (Nov. 1) regards its efficiency as probably low, but thinks that the reduction of cost of carbons, "the possibility of using a low current, and the convenience of being able to connect lamps singly across circuits of one hundred volts," will render its success probable. It says that, "for lamps burning ten hours per night for a year, the length of carbon used in the old form to that in the 'Jandus' lamp is something like as five hundred and sixty feet is to thirty-five feet. The carbons burns fairly flat, instead of pointing and cratering on the negative and positive poles respectively. This result was to be expected when we take into account the long arc, the low value of the current, and the absence of an atmosphere surrounding the arc conducive to combustion. Prof. Silvanus Thompson has shown that the result of surrounding the arc with chlorine or carbonic oxid is that the carbons burn flatter, with a less perfectly developed point and crater. These results, together with state of the carbons in the 'Jandus' lamp, seem to prove the truth of the suggestion, which was made some time ago, that the cause of the peak on the negative carbon is the absence of an oxidizing agent in that region. Mrs. Ayrton has lately shown that the negative is less pointed, the smaller the current and the longer the arc. These three reasons for the flat burning of the carbons are all concurrently present in the 'Jandus' lamp in a high degree, compared with the usual arc lamp."

National Board of Fire Underwriters.

A RESOLUTION passed at a meeting of this board held Dec. 10, to revise rules for installing electric wires, has met with severe criticism. It is as follows:

"*Resolved*, That the superintendent be authorized, until further notice, to approve the use of the Attix tube and wire, when equal in quality and insulation to the samples submitted to this Board and tested, under the same conditions where tubing would be permitted; provided that there is no splicing or tapping of the wire, but that its introduction shall be in all cases by the loop system; that in new buildings when necessary to carry it between floors and plastering it shall be through holes bored in the beams, not less than two inches apart, a single conductor in each hole, out of the reach of nails; and in old buildings where necessary to carry it within the reach of nails it shall be protected by some device from perforation; and provided further that the wire and tube be carried intact into the cut-out boxes, and that in no case shall the outer covering be removed before introducing the core wire into the cut-out box."

Electrical Review, (Dec. 18) says the use of American Circular Loom Conduit, as such was also severely criticized. The resolution may be reconsidered.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting.

*2477. The Jandus Arc Lamp. Ill. (An account of a visit to the works of Messrs. Drake and Gorham, with the object of inspecting the working of the above named lamp, the principle of its action, and the facilities for its manufacture. It is claimed that this lamp, with a single pair of carbons will run without retrimming for 200 hours). Elect'n–Nov. 1. 1800 w.

2483. The New Electric Lighting Plant of the City of Chicago. Ill. (A description of the recently erected arc lighting plant at Halsted St. and Blue Island Ave). Elec Ind–Nov. 1600 w.

2544. The Reactance System of Arc Lighting. Ill. William Smith Horry (A description of a method of working arc lamps in series from the primary circuit of alternators without using a transformer, resistances, fuses, etc, to each lamp, and which is quite comprehensive enough for modern times, since a whole city can by this method be lighted from one machine). Elec Eng–Nov. 13. 1800 w.

2584. Pollak's Gleichrichter. F. H. Mason (Abstract from report of U S. consul-general at Frankfort, Germany. A device invented by a Frankfort engineer, which solves the difficulty of converting an alternating into a direct electrical current with the loss of but a trifling percentage of its energy). W Elec–Nov. 16. 800 w.

2694. West Side Park Lighting System. Ill. (One of the largest arc lighting plants in Chicago, which will illuminate Humboldt, Garfield and Douglas parks and the connecting boulevards. Description, slightly abridged, from report of Mr. Forrée Bain, who planned the system). W Elec–Nov. 23 4800 w.

2750. The Use of Storage Batteries in Electric Lighting. Francis B. Crocker. (A communication read before the Amer. Inst. of Elec. Engrs. Considers separately eight principal uses. 1. To supply portable electric lamps. 2. To take up fluctuations and thus steady the voltage or current. 3. To furnish energy during certain hours of the day or night and enable the machinery to be stopped. 4. To aid the generating plant in carrying the heavier load which usually exists for only an hour or two. 5. To make the load on the engines more uniform by charging the battery when the load is light. 6. To transform from a higher to a lower potential by charging the battery in series and discharging it in parallel, or *vice versa*. 7. To subdivide the voltage and enable a three or a five wire system to be operated with a single dynamo. 8. To supply a current from local centres or sub-stations). Elec Eng–Nov. 27. 3000 w.

*2820. Tests of Incandescent Lamps (Gives a method whereby it is claimed the value of lamps to consumers may be obtained). Ind & Ir–Nov. 22. 1000 w.

†2878. Some Formula for the Calculation of Wires. Edward R Keller (Return Loop System. The object of the paper is to determine which of the methods ordinarily employed will give the most satisfactory results, and to present formulæ by which the wiring in such cases may readily be calculated). Jour Fr Ins–Dec. 900 w.

2942. A Model Electric Lighting Franchise for Montclair, N. J. (A copy of the ordinance granting the franchise, with remarks). Eng News–Dec. 5. 2500 w.

*2969. The Electric Wiring Question. Fred Bathurst (A paper read before the Inst. of Elec. Eng., England. Treats of the development and growth of wiring, technical requirements, present method, the advantage of tube or conduit methods, the superiority of an insulating tube, etc.) Elec Eng. Lond–Nov. 29. Serial. 1st part. 3500 w.

*2975. Concentric Wiring. Sam Mavor (Paper read before the Inst. of Elec. Engs., Eng-

land. General remarks on various systems of wiring, specially presenting the advantages of concentric wiring). Elect'n–Nov. 29. 9000 w.

Power.

*2481. An Electro-Magnetic Railway System. Ill. (A description of the system introduced into England by the Westinghouse Company, with reference to the Lineff system). Elec Rev, Lond–Nov. 1. 1400 w.

*2482. The Diatto Underground Conduit System. Ill. (Abstract from the *Elektrotechnische Zeitschrift*. Seems to be a combination of the Lineff and the Westinghouse systems. It is similar to the Lineff in that it carries the electro magnet on the car, but it approximates to the Westinghouse in carrying a collecting bar, which collects current from metal studs). Elec Rev, Lond–Nov. 1. 600 w.

2484. The Electrical Development of the Falls of the Willamette. Ill. (Description of a long distance transmission plant at Oregon City, for supplying Portland and suburbs, twelve miles away. The total power of the fall is estimated at 50,000 horse-power. The completed plant will develop 12,500 horse-power). Elec Ind–Nov. 1400 w.

2487. The Electrical Plant of the Waterloo and City Railway. Ill. R. W. Weeks (A brief account of the general arrangement of the works). Elec Eng, Lond–Nov. 1. 2200 w.

*2492. On Hydro Electric Installations. C. S. Du Riche Preller (The first part contains an introduction which makes a classification of the applications of single phase, two phase and three phase alternate current. This is followed by an illustrated description of the two phase installation at Baden,—the first of a series of descriptions of a number of notable installations carried out by Messrs. Brown, Boveri & Co. of Baden, in various parts of Europe which are to be presented). Engng–Nov. 1. Serial. 1st part. 1700 w.

2588. The Power Plant of the Philadelphia and Reading Terminal Station. Joseph M. Wilson (Extract from a paper presented to the Am. Soc. of Civ. Eng. Description with drawings). Eng Rec–Nov. 16. 4500 w.

2596. Central Station Economics. Arthur V. Abbott and Franz J. Dommerque (Part I is a prefatory introduction consisting of a general statement of the conditions affecting the cost of producing power, with a scheme of the manner the subject is to be treated. Part II. will be an analysis of the elements involved in power production and delivery. Part III. Conclusion. Part IV. Relation of load line to design of plant). Elec Engng–Nov. Serial. 1st part. 3000 w.

2638. Effect of the Three–Phase System on Electric Power Transmission. Irving Hale (The enormous extension of the field of electric transmission by the introduction of the multiphase alternating system is shown, and its practical success demonstrated). Min Ind & Rev–Nov. 14. 1200 w.

2683. Storage Batteries for Railways. Maurice Barnett (A paper emphasizing the great value possessed by storage batteries, not in furnishing direct motive power, but when used in connection with railway power plants). Tradesman–Nov. 15. 2000 w.

*2736. The Electric Equipment of Messrs. Siemens' Works. Albion T. Snell (From a forthcoming work entitled "Electric Motive Power in Practice." An illustrated description of these works, with tests which seem to prove that power distributed from an electric central power station costs less than when derived from independent steam engines). Elect'n–Nov. 15. 3600 w.

2748. A Chimney Two Hundred and Thirty Feet High. Ill. (Interesting engineering feat in which an electric hoist rendered valuable aid). Elec Rev–Nov. 27. 700 w.

2749. The New Storage Battery Cars on the Madison Avenue Line, New York. Ill. (Description of the batteries, their location, and handling, shifting devices, etc. Also brief descriptions of the car bodies, truck and controller and the generating plant). Elec Eng–Nov. 27. 2200 w.

2751. The Storage Battery for Central Stations. Arthur E. Childs (Abstract of a paper presented at the meeting of the Amer. Inst. of Elec Engrs Considering, in a general way, the application of storage batteries to the wiping out of the fluctuations and variations as they come upon the dynamos and engines). Elec Eng–Nov. 27. 3000 w.

2782. Electric Transportation of Express and Mail Matter (Illustrations of the proposed plan of construction, with explanation of system). Elec Age–Nov. 30. 1400 w.

2783. The Storage Battery or the Gas-Engine as an Auxiliary. Nelson W. Perry (Topical communication presented to the meeting of the Am. Inst. of Elec. Engrs. The author's opinion regarding the use of storage batteries for the purpose of relieving electrical systems of the strain due to sudden fluctuations of load. He considers the gas-engine preferable if economy is important). Elec Age–Nov. 30. 2200 w.

*2796. Sayers' Electric Motor and Generator. (An illustrated description of a new inclosed motor). Engng–Nov. 22. 500 w.

*2884. The Shunt Dynamo. Max Osterberg (Lecture delivered before the Henry Electric Club. Explanation of the principle and action). Elec Pow–Dec. 2100 w.

*2885. The Series Dynamo. Ill. Joseph T. Monell (Lecture delivered before the Henry Electric Club. Descriptive of different types). Elec Pow–Dec. 2500 w.

2901. Automatic Shoe Blacking Machine. Ill. (Descriptive of an electrical machine for named use). W Elec–Nov. 30. 600 w.

2902. Automatic Time Cut-out. Ill. (A device designed by F. B. Badt of Chicago, which the inventor claims will entirely obviate the short-circuiting of batteries). W Elec–Nov. 30. 1300 w.

2909. The Niagara Falls Hydraulic Power and Manufacturing Co.'s New Work. Ill. Orrin E. Dunlap (Descriptive). Elec Eng–Dec. 4. 1600 w.

2910. Direct vs. Alternating Currents for Long Distance Transmission. William Baxter, Jr. (The purpose of the article is to show that the direct current is more desirable than the alternating for the transmission of energy over long distances). Elec Eng–Dec. 4. Serial. 1st part. 2500 w.

2911. An Amalgamator Operated by Electric Motors. Ill. (An application of electricity of interest to the mining industry). Elec Rev–Dec. 4. 450 w.

2933. Electricity in Stone Quarries. Ill. (Consideration of the advantages, with an account of the electrical installation at the Hainaut Quarries, Soignies, Belgium). W Elec–Dec. 7. 1500 w.

2998. The Nevada County Power Transmission. Ill. (Description of an installation under many difficulties). Jour of Elec–Nov. 1600 w.

Telephony and Telegraphy.

2585. The Ten-word Telegram (Treating of changes in prices of messages in more recent years, comparing with previous prices, and the strong tendency to keep within the ten word limit). W Elec–Nov. 16. 1500 w.

2604. The Boughton Telephotos for Long Distance Visual Signalling. Ill. (Apparatus devised by C. V. Boughton. Description. Within the limits of vision it is asserted to allow of more rapid and certain communication than any other visual signalling system). Elec Eng–Nov. 20. 600 w.

*2711. Municipal Telephony. A. B. Bennett (A summary of the present position of telephones in the United Kingdom, and an account of what has been done in Norway are given in the present number). Elec Rev–Nov. 15. Serial. 1st part. 2800 w.

2769. How the Telephone Was Invented.—A Chat with Inventor Bell. Frank G. Carpenter, in *Washington Star* (An interesting talk on the telephone, Volta Bureau, and Mr. Bell's work in general). Inv Age–Nov. 4000 w.

Miscellany.

*2471. Are We Educating Too Many to be Electricians? Henry Floy (Showing, by specially-gathered tabulated statistics, that graduates in electrical-engineering are less successful than other technical specialists in obtaining remunerative employment). Eng Mag–Jan. 2700 w.

*2476. Energy Loss in Dielectrics. P. Gasnier (A review of what has already been done toward elucidating this question, and what are the conclusions which different experimenters have drawn from their work). Elect'n–Nov. 1. 2200 w.

2485. Practical Electrical Testing. Ill. C. C. Haskins (Brief descriptions of three methods for making a test or measurement of capacity, insulation, resistance and conductivity). Elec Ind–Nov. 800 w.

2486. The Design and Construction of a Motor Starting Box. Ill. E. D. (A consideration of the main points of a starting rheostat for a motor of five horse power capacity, built for 230 volt circuits). Elec Ind–Nov. 1100 w.

2439. The Gravity Alarm Battery. William Brophy (Extract from address before the Massachusetts State Firemen's Asso. "What substitute (if any) is there for the gravity battery for fire alarm purposes that would be equally reliable and less expensive to maintain?"). Fire & Water–Nov. 9. Serial. 1st part. 2000 w.

2568. A Suggestion for a Dynamometer. Ill. George T. Hanchett (A description of one that is cheap and claimed to be as accurate as any of its class). Elec Wld–Nov. 16. 300 w.

2569. On an Approximate Linear Relation between Coercive Force and Maximum Cyclic Intensity in Iron and Steel. Edwin J. Houston and A. E. Kennelly (Results pointing to the existence of such relation). Elec Wld–Nov. 16. 900 w.

2581. Chase Electric Cyclorama. Ill. (An apparatus devised by Charles A. Chase consisting of "an ingenious combination of arc lamps, fed from rubbing contacts on a circular track suspended from the ceiling of an exhibition room, and an arrangement of especially devised projecting lenses and a continuous photographic film, with the necessary mechanism for blending and adjusting the projected sections of the picture in one complete cycloramic view). W Elec–Nov. 16. 900 w.

*2600. The Magnetic Field of a Rectangular Coil. G. M. Minchin (Showing how to calculate practically the component of magnetic force parallel to the axis of a coil of any dimensions at any point in space, and also the value of the potential due to any flat rectangular coil). Elect'n–Nov. 8. 2200 w.

*2601. The Magnetic Force of Any Point in a Plane Due to Electric Currents. Alexander Russell (An interesting graphical method, easily applied in practice with perfectly satisfactory results). Elect'n–Nov. 8. 800 w.

2605. The Durability of Porcelain as an Insulator. James Pass (In favor of its use, and cautions regarding quality). Elec Eng–Nov. 20. 1200 w.

2606. Canal Improvements and the Lamb Motor on the Erie Canal. Ill. (A description of this electric motor and its operation). Elec Eng–Nov. 20. 1000 w.

*2635. The Behavior of the Carbon Brush on the Commutators of Direct Current Power Generators. Harris J. Ryan (Descriptive of the manner the carbon brush takes the current off the commutator so that it is unnecessary to have the brushes moved from point to point with every variation of load in order to avoid sparking). Sib Jour of Engng–Oct. 1100 w.

2649. Good Regulation and the Shaft Governor. Ill. E. T. Adams (A consideration of the problem of securing good regulation from a shaft governor. The directions are written especially for the men actually in charge of a plant). Elec Wld–Nov. 23. 4200 w.

2650. Theory of Dimensional Formulas. Percy H. Thomas (An interesting contribution to this subject). Elec Wld–Nov. 23. 1700 w.

2651. Armature Winding and Connecting Considered as a Mathematical Problem. Ill. Harrison H. Wood (The writer has endeavored to develop the problem as a purely mathematical

one, paying no attention to practical methods and devices made use of in winding and connecting, nor to the relative advantages of different methods, where such exist, of grouping the conductors and of connecting them to the commutator). Elec Wld–Nov. 23. Serial. 1st part. 1800 w.

2652. The Inefficiency of the Direct Methods of Converting Heat into Electrical Energy. Leon Le Pontois (Paper read before the Engs. Soc. of W. Penna. The writer's reasons for believing that the most economical solution of the problem lies in the construction of a more perfect heat engine). Elec–Nov. 20. Serial. 1st part. 3000 w.

2654. The Department of Electricity at the Atlanta Exposition. Luther Stieringer (From *Dixie*. An account of exhibits with remarks on advances made since 1893). Elec–Nov. 20. 1200 w.

*2669. The Simple Transformer Diagram. Frederick Bedell (The production of an electromotive force in the secondary. The essential relations between the various quantities involved in the simple transformer). Sib Jour of Engng –Nov. 2500 w.

†2701. The Rating and Behavior of Fuse Wires. Ill. W. M. Stine, H. E. Gaytes, and C. E. Freeman (Paper read before the Amer. Inst. of Elec. Engs. with discussion. Investigations of fuse wires. The experiments cover the entire subject and the results are presented in tabulated form, with numerous diagrams, illustrating curves of sensitiveness, curves of fusing points, and curves of fatigue. Seven fundamental conclusions were announced and discussed). Trans Am Inst of Elec Engs–Oct. 7500 w.

*2710. The History of a Great Electrical Company (Some interesting information concerning the past history and future projects of the Allgemeine Elektricitäts-Gesellschaft, Berlin, obtained in an interview with Herr Rathenau). Elec Rev–Nov. 15. Serial. 1st part. 1200 w.

*2737. The Carborundum Works at Niagara Falls. Ill. Orin E. Dunlap (Description of the manufacture of carborundum as now carried out). Elect'n Nov. 15. 1800 w.

2784. Insulation of Overhead and Underground Circuits Having a Difference of Pot ntial of 2000 Volts and Over. William Brophy (Abstract of a paper read before the Electric Potentials, Boston. The author believes that all high potential circuits should be placed underground, but as they are not so placed, he deals with the question of how to construct and insulate them). Elec–Nov. 27. 2200 w.

†2850. Professor Forbes on "Harnessing Niagara." Ernest A. Le Sueur (A severe criticism of Prof. Forbes' recent article in Blackwood's Magazine in which the truth of some of the statements therein made are denied, and the propriety of the position assumed by the author in the article criticised, is questioned). Pop Sci M–Dec. 2700 w.

*2882. Some Observations upon Electrical Engineering Progress in Europe. Charles T. Rittenhouse (An account of what appeared to the writer some of the chief features of construction and operation). Elec Pow–Dec. 4500 w.

*2883. Electrical Equipment of Modern Office Buildings. Joseph Sachs. (An explanation of the various applications of the electric current considered essential in such buildings). Elec Pow–Dec. 2600 w.

*2900. The Hysteresis of Iron in an Alternating Magnetic Field. Francis G. Baily (Experiments undertaken to prove whether the same law of hysteresis holds in a rapidly alternating field as in one of very slow change, and the curve of hysteresis and induction show a flexure, reaching a maximum, and after that remaining constant. Concluding that the hysteresis of iron arrives substantially at a maximum when the iron becomes saturated, and that the function expressing the hysteresis in terms of the magnetic condition of the iron should depend not on induction, but on the intensity of the magnetization, with at most a small correction in terms of the former). Elect'n–Nov. 22. 2500 w.

*2907. Development of the Electro-Depositions of Gold in the Transvaal. Emile Andreoli (Facts and figures taken from a recently published report of the Rand Central Ore Reduction Co., Limited, showing surprising progress during the last year). Elec Rev, Lond–Nov. 22. 1700 w.

2914. The New York Industrial Building, Where the Grand Electric Light and Railway Exhibit of 1896 Will be Held. Ill. (Details of construction and arrangement). Elec–Dec. 4. 2000 w.

2915. Variation in Electrical Conductivity of Metallic Wires in Different Dielectrics. Fernando Sanford, in the *Physical Review* (Giving the results of careful experiments by the writer and other investigators). Elec–Dec. 4. Serial. 1st part. 1600 w.

2934. How Shall We Insulate Our Overhead Wires? (Editorial remarks with extracts from contributions by William Brophy and B. J. Arnold). W Elec–Dec. 7. 4200 w.

2951. Formulas for Winding Magnets. I. A. Taylor (Method for finding the size and number of turns of wire on a magnet). Elec Wld–Dec. 7. 500 w.

2952. Hydro-Electrothermic Heating. Paul Hoho (Treating of the production of heat by the direct conversion of electrical energy. Description of systems and industrial applications). Elec Wld–Dec. 7. 4000 w.

*2973. Which Electrolytic Methods Can Be Used with Advantage in Analytical Practice? Dr. Bernhard Neumann (From *Zeitschrift für Elektrochemie*. A condensed article which contains much valuable information). Elect'n–Nov. 29. 4000 w.

*2974. The Crompton Potentiometer: Its Use and Capabilities. W. C. Fisher (Notes and suggestions upon the working and capabilities of this special type of instrument). Elect'n –Nov. 29. Serial. 1st part. 2800 w.

*2994. The Deflected Arc System of Electric Welding. Ill. (Complete detailed description of samples of work performed by the Zerener system). Engng–Nov. 29. 600 w.

INDUSTRIAL SOCIOLOGY

Plutocracy and Paternalism.

PROFESSOR LESTER F. WARD, in *The Forum* for November, gives the above title to an article which will interest students of sociology, whether they can accept his views or not. At the outset he asserts the impossibility of making anything more than an approximation to "an unbiassed analysis of the true meaning of these terms in their relation to the existing state of affairs"; and he evidently leans toward the paternalistic side. He states the proposition that, while on general principles wealth can easily be proved not to be a measure of the worth of those who possess it, "justly or unjustly" it has been established as a standard of worth by society. This is the evolutional result of "universal competition . . . where the fittest to survive is always the one who can gain possession of the greatest amount of this world's goods. It has, therefore, a rational basis, a substratum of truth on which to rest. We are chiefly concerned with it here as a fact. It is universal. Those who most thoroughly condemn it are influenced by it. The force that works against it in society is not the absence or weakness of the sentiment itself, but another and wholly dissimilar feeling,—*viz.*, sympathy. This sentiment is not rational, but illogical, as shown by the fact that men give alms to satisfy temporary want rather than opportunity to supply permanent needs. But of the other sentiment, which may be called 'plutolatry,'—the worship of wealth,—even the victims show traces, and, in denouncing the rich, they unconsciously attribute to them a personal dignity proportional to their wealth." This regard for wealth is, therefore, not an evanescent social development. "Wealth gives not only ease, plenty, luxury, but, what is infinitely more, the respect of all and the envy of the less favored. It gives, in a word, superiority; and the strongest craving of man's nature is in one way or another to be set over his fellows. When all this is considered, the futility of the proposal of certain reformers to eradicate the passion for proprietary acquisition becomes apparent. It may be assumed that this passion will continue for an indefinite period to be the ruling element of the industrial state. That it has done and is still doing incalculable service to society few will deny. That it may continue to be useful to the end of our present industrial era will probably be admitted by all but a small class."

The accumulation of wealth implied in the term "plutocracy" is not what Professor Ward deprecates. The mere accumulation of (even colossal) wealth cannot, in his opinion, become a social evil, except in one way; its transmission to heirs may in time produce "a non-industrial class in perpetuity." However, such a result may, he thinks, be prevented by limiting the power of bequest. Professor Ward does not seem to perceive that such a limitation would have to be accompanied by a legal limitation of gifts during life, to make it at all effective. Such a curtailment of personal liberty would not be practicable. It would be as easy to limit the personal acquisition of wealth, which he regards as a blessing. Moreover, it is within the non-industrial class that the largest acquisitions of wealth are made, if the term "industrial class" properly includes only producers of wealth. Production and accumulation are quite distinct, and a good thinker should not confuse their meaning.

As to paternalism, the author says that "literally. . . . paternalism in government would be restricted to cases in which the governing power is vested in a single person, who may be regarded as well-disposed and seeking to rule his subjects for their own good, as a father governs his children. But a ruling family, or even a large ruling class, may be supposed to govern from similar motives. In either case the governed are not supposed to

have any voice in the matter, but are cared for like children by the assumed wisdom of their rulers. How far from true paternalism is anything that exists in this or any other civilized country to-day may, therefore, be readily seen. No one will claim that there is any danger, in a representative government with universal suffrage, of any such state being brought about. This shows at the outset that the term is not used in its original and correct sense, but is merely borrowed and applied as a stigma to certain tendencies in republican governments which the users of it do not approve. What are these tendencies? In general, it may be said that they are tendencies toward the assumption by the State of functions that are now entrusted to private enterprise."

Without any limit to these tendencies, the result would be a Socialistic system of government. Were the State to relinquish functions it has assumed, there would be an end of government. The moderate view reduces the question to one of policy, rather than of principle to be carried out to its extreme and logical application. There are dangers in both directions, if pursued too far.

"If we look for precedents and historical examples, we find great diversity. If we take the question of government telegraphy, we find that the United States is almost the only country in the civilized world that has not adopted it, while the reports from other countries are practically unanimous in its favor. That such a movement should be called paternalism is, therefore, quite gratuitous, and must spring from either pecuniary interest or unenlightened prejudice. From this on, up to the question of abolishing the private ownership of land, there is a multitude of problems, presenting all shades of difference in the degree to which the principle of State action is to be applied in their solution. They need to be fearlessly investigated, coolly considered, and wisely decided in the true interests of the public. It was not the purpose of this article to discuss any of these questions, but simply to mention them in illustration of the popular use of the term 'paternalism.' It is clear that that term is employed solely to excite prejudice against the extension of the functions of the State, just as the term 'plutocracy' is used to arouse antagonism to the wealthy classes. The words have in these senses no natural meaning, and, with intelligent persons, should have no argumentative weight."

That each individual will seek his greatest gain is enunciated as the "first law of economics"; and it is regarded as "both natural and right" that he should do this "rather irrespective of the rest of the world." This was true in the primitive state of mankind, and it is equally true now, "when business shrewdness is supreme." Government, originally "occupied solely with abuse caused by brute force," is still occupied with this class of abuses considered "relatively trifling as compared with advantage gained by cunning, by superior knowledge,—if it be only of the technicalities of the law,—and which, though not (legally) a crime, may be in spirit as bad as that of highway robbery, and its consequences a thousand times worse."

This brings us to the nub of Professor Ward's paper.

He regards society as suffering from under-government, and government itself as "to-day powerless to perform its original function of protecting society." Artificial conditions have nullified "the operation of the natural law, on the lower plane." Indeed, the effect is reversed, and, instead of developing strength, either physical or mental, through activity incident to emulation, it tends to parasitic degeneracy through the pampered idleness of the favored classes. Social conditions "embodied in law," and largely consisting of statute law, supplemented by judicial decisions, often immemorial, and belonging to the *lex non scripta*, intended to make men secure in their possessions and safe in their business transactions, have, "owing to entirely changed industrial conditions, become the means of throwing unlimited opportunities in the way of some, and of barring out the rest from all opportunities."

"And thus we have the remarkable fact,

so persistently overlooked in all the discussions of current questions, that government, which fails to protect the weak, is devoting all its energies to protecting the strong. It legalizes and promotes trusts and combinations; subsidizes corporations, and then absolves them from their obligations; sustains stock-watering schemes and all forms of speculation; grants without compensation the most valuable franchises, often in perpetuity; and in innumerable ways creates, defends, and protects a vast array of purely parasitic enterprises, calculated directly to foster the worst forms of municipal corruption. The proofs of each one of these counts lie about us on every hand. Only those who are blinded by interest or prejudice can fail to see them.

"There is no greater danger to civilization than the threatened absorption by a few individuals of all the natural resources of the earth, so that they can literally extort tribute from the rest of mankind. If half a dozen persons could get possession of all the bread-stuffs of a country, it would justify a revolution. Fortunately, from the nature of this product, this is impossible, although long strides in that direction have from time to time been taken. But it is otherwise with some other products, which, if less indispensable, are still among the modern necessaries of life. All the petroleum of this country is owned by a single trust. If men could not live without it, there is no telling how high the price could be raised. Nothing limits it but the question how much the public will pay rather than do without. That indispensable product, coal, has well-nigh reached the same stage through the several railroad combinations that now control it. That which costs sixty cents to mine, and as much more to transport, cannot be obtained by the consumer for less than five or six dollars. Does it speak well for the common sense of a great people that they should continue to submit to such things? There seems to be no remedy except in the power of the nation."

The conclusion is that government protection should be extended as rigidly to the property of the poor as to that of the rich, and that the paternal solicitude of the government for trusts and monopolies should be directed to the interests of the general public. "If we must have paternalism, there should be no partiality shown in the family."

Employer and Employee Under the Common Law.

THE compilation prepared for the November *Bulletin of the Department of Labor*, by Victor H. Olmstead and Stephen D. Fessenden, is one of the most valuable documents supplied by the department during the present year. In it are contained the "principles, usages, and rules of action . . . . which have grown into use by gradual adoption, without legislative authority, and have received, from time to time, the sanction of the courts of justice," and which now constitute the common law of the relations existing between employers and employed. We shall endeavor, in what follows, to make such an abstract of this paper as will furnish the reader with the most important principles still recognized as not having been altered by legislation, quoting first the definitions of "master" and "servant" as presented by the authors. "A master is variously defined as one who has in his employment one or more persons hired by contract to serve him either as domestic or common laborers; one who has the superior choice, control, and direction, whose will is represented not merely in the ultimate result of the work in hand, but in all its details; one who is the responsible head of a given industry; one who not only prescribes the end, but directs, or may at any time direct, the means and methods of doing the work; one who has the power to discharge; a head or chief; an employer; a director; a governor.

"A servant is one who is employed to render personal service to his employer otherwise than in the pursuit of an independent calling, and who, in such service, remains entirely under the control and direction of the latter."

The relation is established by contract, which may be either written or verbal, ex-

press or implied, when both parties are legally qualified to make contracts. The contract may be entered by either party through the action of any duly authorized agent.

The term of employment, in the absence of an express agreement, is the term for which the wages rate is stipulated. Thus a workman paid by the day is employed for a day; one paid by the week is employed for a week, etc. If one thus employed claims that any change in the contract has been made in this particular, the burden of proof of such an allegation rests upon him.

A contract for a term longer than one year must be in writing, and signed by the party against whom it is sought to be enforced. In the absence of an express contract, a servant may recover such compensation as he can show he had the right to expect for his service under the circumstances of the case.

A master is bound to furnish the employment he contracts to furnish. A workman employed by the day, week, month, or year, may, in the absence of express agreement, demand his pay accordingly,—that is, daily, weekly, monthly, or yearly; daily, weekly, or monthly wages imply payments each day, week, or month, when other terms are not agreed upon. A husband may contract for the labor of a wife, and may collect her wages unless they are separately claimed by her, but a wife is not responsible for the wages of a servant employed by her husband. Disputes as to amounts of compensation are questions for a jury. When not otherwise stipulated, wages must be paid in cash, and directly to the servant. Incompetence justifies a discharge before the expiration of a term of service; but the incompetency must be clearly shown. When discharged before the end of a term agreed upon, the employee may recover the amount stipulated for the remainder of the term, less the amount earned, or the amount that, with reasonable effort to obtain work, he could have earned, during the period. When wrongfully discharged, he may proceed to recover pay for the remaining part of his term of employment as follows:

"(1) He may sue at once for the breach of contract, in which case he can only recover his damages up to the time of bringing the suit; (2) he may wait until the end of the contract period, and then sue for the breach; (3) he may treat the contract as existing, and sue at each period of payment for the wages then due; (4) he may treat the contract as rescinded, and sue immediately for the value of his services performed, in which case he can only recover for the time he actually served."

A number of persons may agree with each other that they will not work for, or deal with, certain persons provided no unlawful purpose is sought to be carried out by such an agreement, in which case such an agreement would be in itself unlawful.

"On the other hand, a combination of employees having for its purpose the accomplishment of an illegal object is unlawful; for instance, a conspiracy to extort money from an employer by inducing his workmen to leave him and deterring others from entering his service is illegal; and an association which undertakes to coerce workmen to become members thereof, or to dictate to employers as to the methods or terms upon which their business shall be conducted, by means of force, threats, or intimidation interfering with their traffic or lawful employment of other persons is, as to such purposes, an illegal combination.

"Unlawful interference by employees, or former employees, or persons acting in sympathy with them, with the business of a railroad company in the hands of a receiver, renders the persons interfering liable to punishment for contempt of court.

"It has been held, however, that employers in separate independent establishments have no right to combine for the purpose of preventing workmen who have incurred the hostility of one of them from securing employment upon any terms, and by the method commonly known as blacklisting debarring such workmen from exercising their vocation, such a combination being regarded as a criminal conspiracy.

"Employers are ordinarily responsible

to employees for injuries resulting from negligence on the part of the employer, provided the employee does not contribute to the risk by his own negligence. Employers must furnish reasonably safe tools and machines, and not in any way expose their workmen to unusual dangers.

"Workmen in the employ of a common master, subject to the same control, paid from a common fund, and engaged in promoting a common object, are in common law fellow-servants. A master is not ordinarily liable for injuries to a workman received through the negligence of a fellow-servant, though circumstances may in some cases make such negligence his own; in the latter case he incurs liability."

Sundry Labor Questions.

UNDER the above title, the *Journal of Gas Lighting*, a technical paper which discusses sociological subjects with exceptional ability, reviews (Oct. 29) the present industrial situation in England. While the improvement in general industry has brought with it "the inevitable concomitant strikes for higher wages by some organizations of skilled workmen, the members of the coal miners' unions, and other followers of rough trades," have enough to do to make ends meet at the close of each week. And while the English press very generally is commenting upon the strikes and lamenting the embarrassments to trade which they have caused, profit-sharing, a system which our contemporary has been strenuously advocating as a sovereign remedy for strikes, is scarcely at all discussed in other journals. This indicates a want of appreciation of arguments favoring profit-sharing, or, what is more probable, a mistrust of its practicability as an industrial system under present commercial conditions.

Another phase of the situation noticed is "that, when it comes to a question of striking or not striking, the old unions of skilled workers are quite as likely to take it fighting as the 'new' unions, which are supposed to differ from them greatly in many respects. . . . We have not been able to forget the performances of the Sheffield trade unions of the last generation,—unions of skilled workers surely, if such could have been found anywhere,—and cannot believe that organizers of close societies avowedly existing for the sole benefit of their members will ever be squeamish as to the means they employ to gain their ends. It stands to reason that the responsible managers of trade societies with money as well as credit to imperil by any indulgence in lawlessness will be chary of encouraging violent counsels in regard to the conduct of disputes with employers. Moreover, the more perfectly they succeed in getting within their membership all the available followers of trades which cannot be learnt in an hour by the first comer, the less will be their temptation to practise other than waiting tactics for bringing disputes to an end. All the same, when it is brought to ultimate analysis, the way in which the old trade unions apply the principle of unity in practice will be found to differ very little, if at all, from that favored by the new unions. It should not be overlooked by those who reflect upon this similarity of methods in trade unionism that some of the most savagely conducted of the conflicts of new unions were carried on under the auspices of men who had learnt in an old trade union of what spirit the creature really is."

The new unions are very severely—we had almost written "savagely"—criticised. They are stigmatized as "so many mobs, influenced, as mobs are influenced, by power of tongue and lung; and professional Socialists are apt at this kind of thing. The old trade societies are largely composed of respectable men,—family men and men with money savings. It is useless to dangle collectivism as a bait before such hard-headed as well as horny-handed customers. The leaders they are prepared to follow are not street-corner spouters, but men like themselves, with a bit of money laid by, and a keen eye upon the means of increasing the store. Yet does anybody think that such men will shrink from fighting their employers to the last gasp, if they are convinced that their wages ought to be a halfpenny an hour more? Not they; nor are they men to

stick overmuch at the adoption of any means for gaining their end. They will not stone a recalcitrant employer, or go whining to a lord mayor for help before they have been out a month; but there is that in them which would render their company undesirable by a 'free laborer' of their own class when they had grown desperate."

The words "free laborer," used to distinguish a man not enslaved by a union from one so bound, are particularly forcible here.

The sympathy of the modern philanthropist is more enlisted by the later troubles of the "new" unions than by those of the "old," because the latter almost uniformly involve only "questions of work or of wages, or of working hours," when their strikers are not ordered out "on principle," the latter being something which does not concern the general public.

"The philanthropist may regard with vague benevolence the spectacle of a body of comparatively well-to-do artisans in conflict with their employers upon the question of whether they should be paid a halfpenny an hour more or less, or whether the factory bell should ring at this or that hour. He may entertain a general impression that the men are probably in the right of it; but, so far as he and his class are concerned, the issue is no concern of theirs. There is nothing to be made out of it by an impartial 'conciliator,' who would have to begin by confessing that the considerations bearing upon the point at issue were too technical for him to understand, much less to pronounce judgment upon. But when it is a case of a whole industrial population of poor fellows claiming no more than a 'living wage,' which the ogre-like employers do not see their way to paying,—ah! then the philanthropist (at other people's expense) sees his chance; and usually, like Bret Harte's hero, he 'goes for it then and thar.'"

New York is cited as a specimen municipality wherein this kind of philanthropy has resulted in a rate of wages "fixed by law at about double current rates." Our contemporary, however, in attributing this to philanthropy, seems to have overlooked the influence which our corrupt municipal government has had in fixing rates of wages, although the expression "philanthropist at other people's expense" may perhaps be intended to cover that kind of politician, who, if a philanthropist in any sense of the word, is always such at other people's expense and for his own profit.

A powerful argument in favor of profit-sharing is concluded as follows: "Apart from this aspect of militant trade unionism, and reverting to the question of rate of wages, it is obvious that, where profit-sharing exists, there can be no temptation to strike for increased pay supposed to be warranted by an improved state of trade. If the antecedent condition existed, it would show itself at the proper time in heightened profits for all the partners; and the funds of the unions would not be spent in testing for the fact by a method as wasteful as the legendary Chinaman's expedient of burning down his house whenever he desired to roast a pig."

Prospects of American Export Trade with Japan.

IF a correspondent of the *Chicago News*, Mr. W. Curtis, has gained correct views by his visit to the exposition at Kyoto, the prospects of a future export trade of American general merchandise to Japan are not flattering. The exposition, according to Mr. Curtis, demonstrates the fact that, as expert imitators, the Japanese are in the front rank. He says that the exposition contains in its department of manufactures a sample of almost everything that enters into the wants of civilized men, and most of the articles are exact reproductions of inventions still protected by patents in Europe and the United States.

Japan has hitherto refused to enter into patent and trade-mark treaties, and gives a good reason for her refusal. "The United States and the European powers have refused to recognize Japan as a civilized nation. They have refused to submit their subjects to the protection of our courts, and have forbidden us to make our own tariff. They insist that their subjects in

Japan shall be tried before their own consuls, under the laws of their own country, because our laws are not good enough for them, and they will not allow us to impose a duty of more than 5 per cent. upon imported merchandise. They blame us for not being willing to make a treaty to protect their patents. Under the new treaties that take effect in 1899, Japan will become a member of the International Patent and Trade-Mark Union, and will give the inventions of foreigners the same protection that its own receive. If that is not satisfactory, our government would be willing to have the new treaties go into effect tomorrow, instead of 4 years hence." This is the explanation of the policy of Japan upon the subject of patents, as given by the chief examiner in the Japanese patent office.

Among articles imitated successfully in Japan Mr. Curtis names the following: Hoe perfecting printing presses—copied, name and all; type-setting machines; printers' supplies; Fairbanks' scales; Mason and Hamlin organs; American locks; Pears' soap; Beecham's pills; Bass's ale; Porter's stout; Milwaukee export beer; Eagle brand of condensed milk; Armour's compressed beef; patent safety razors; lamp burners; etc. Some of these articles, it is stated, are selling at one-third the price they bring in the United States.

Physics and Sociology.

THE inadequacy of the methods of physical science when applied to sociological science is well pointed out by Mr. W. H. Mallock in the *Contemporary Review* for December. There has of late been visible an effort to bring sociology under the same methods as those by which physical sciences are studied. "Social science," says Mr. Mallock, "differs from physicial science, not only in having access to two orders of phenomena, whereas physical science has access only to one; but also in the fact that this second order of phenomena, to which physical science offers nothing analogous, is for social science the more important of the two, and demands from it a study concurrent with, and similar to, that bestowed upon the first. . . . When we attempt to apply to the social world these methods and theories which we have applied to and learned from a systematic study of the physical world, and which form for us the type and model of what we mean by science, we are obliged by the very principles of that physical science itself, to do certain things which physical science does not do, and to recognize that, whilst the procedure which it suggests to our intellect may be correct, the model which it actually offers us is altogether inadquate."

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Current Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.

*2464. Representative Money and Gold Exportations. Horace White (Showing the results of fiat money, and that all the money issued by the United States government, except gold and national bank notes, is fiat money, whether metallic or not). Eng Mag-Jan. 3500 w.

*2470. A Piece-Rate System and Shop Management. Fred W. Taylor (Favoring payment of labor at rates determined by analysis of the labor, and so differentiated as to give the superior workman more than the usual rate and the inferior workman less than the usual rate). Eng. Mag-Jan. 4300 w.

2566.—$1. The Custody of State Funds. E. R. Buckley (An explanation of the two methods employed by the United States Government in keeping the public money—the "bank depository system" and "the independent treasury system." Concluding that there are good reasons for discontinuing the latter system, while the former meets with nearly universal approval). An of Am Acad-Nov. 2800 w.

2567.—$1. Railway Departments for the Relief and Insurance of Employés. E. R. Johnson (A study of the railway relief department, the motives which prompted the establishment, the different organizations and history, the pension and superannuation feature, the savings feature, results accomplished and objections raised, special advantages, &c. Concludes that it is an institution of undoubted benefit to the employés, the railway companies. and the public). An of Am Acad-Nov. 14000 w.

†2607. The Improvement of Working-Class Homes. H. M. Bompas (The evils of the present system of taxation in England pointed out and their remedy suggested, and difficulties conceded). Fortnightly Rev-Nov. 4000 w.

We supply copies of these articles. See introductory.

*2663. Labor Statistics (Review of the 2d Annual report of the Labor Department of the Board of Trade). Engng-Nov. 8. 2300 w.

2687. The Relation of the Federal Courts to Organized Labor. William H. Taft (A labored and learned answer to the charge, admitted to be true, that judicial action has been, and is, much more efficient to restrain labor excesses than corporate evils and greed. The justification is found in the nature of the two evils. Physical force is involved in the one and not in the other. The writer regards corporate wrong as in its nature almost wholly beyond the reach of the courts in the United States). Ry Rev-Nov. 16. 2400 w.

*2714. The Latest Labor War (Discusses the dangers of trade unionism in trades which, like transportation, gas-lighting, ship building, telegraphy and postal distribution, are wholly or partly in the nature of a public service). Jour of Gas Lgt-Nov. 12. 2000 w.

*2759. Conditions for American Commercial and Financial Supremacy. Paul Leroy-Beaulieu (The commercial and financial situation is viewed from the European standpoint and found so inexplicable as to excite surprise in the minds of Europeans. The weaknesses of the monetary system in the United States are pointed out and suggestions for improvement are given). Forum-Dec. 5500 w.

*2760. The Nature of Liberty. W. D. Howells (This article takes the ground that the dream of infinite liberty is the hallucination of the anarchist, that is, of the individualist gone mad; and that the moment liberty in this sense was achieved, we should have the rule, not of the wisest, not of the best, not even of the majority, but of the strongest, and no liberty at all. To be free we must be equals in opportunity and safety). Forum-Dec. 3800 w.

*2771. Cotton Mills in the Southern States (Described by an English tourist, who appears to be a practical cotton manufacturer and able to take in the full significance of the southern cotton manufacturing industry). Mach, Eng-Nov. 15. 1300 w.

*2777. Tariff Changes in Italy (A list of articles on which the duties have been altered). Bd of Tr Jour-Nov. 700 w.

*2778. Customs Tariff of Newfoundland (A statement of the rates now levied on merchandise imported into Newfoundland). Bd of Tr Jour-Nov. 2000 w.

*2779. Tariff Changes and Customs Regulations (Russia, Norway, Germany, Netherlands, East Indies, France, Portugal, Spain, Italy, Roumania, United States, Brazil, Argentina, &c). Bd of Tr Jour-Nov. 4500 w.

2785. Employer and Employee under the Common Law. Victor H. Olmsted and Stephen D. Fessenden (First number treats of master and servant definitions; the relation, its creation and existence; the contract of service; combinations and coercion of servants; employer's liability for injuries of employees). Ir Age-Nov. 28. Serial. 1st part. 3500 w.

2812. The Mint Report (An editorial review of the report of the director of the U. S. mint). Bradstreet's-Nov. 30. 700 w.

2813. The Foreign Speculative Outlook (Reviews predictions made in the London *Statist*, the conclusion of which is that there will soon be recovery in the markets for mining shares, unless the eastern political situation grows dar).ker Bradstreet's-Nov. 30 1000 w.

2814. Postal Abuses and Reforms (Reviews the working of the Postal Department for the fiscal year ending June 30, 1895). Bradstreet's-Nov. 30. 1000 w.

2815. Development of Labor Statistics (States not having and those having such bureaus. Review of Bulletin of the National Department of Labor). Bradstreet's-Nov. 30. 800 w.

2816. Manufacturers in Massachusetts (Industrial statistics). Bradstreet's-Nov. 30. 1200 w.

*2822. The Trade of the World (Statistics of I. Exports of different countries in 1883 and 1893. II. Value of the imports received into the principal countries from the United Kingdom, Germany, France and the United States. III. Value of the exports of the principal countries in 1893 to the United Kingdom, Germany, France and the United States, from which it is concluded that notwithstanding the fears expressed by some portions of the British industrial press, the situation of British trade is satisfactory from many points of view). Ir & Coal Tr Rev-Nov. 22. 1100 w.

†2849. Principles of Taxation. David A. Wells (First part outlines the exceptional circumstances under which the author has prosecuted his studies and investigations, dating from the publication, in 1864, of his book "Our Burden and Our Strength"—which became one of the current publications of the war period. Subsequent numbers will deal with the subject under proper and consecutive subdivisions). Pop Sci M-Dec. Serial. 1st part. 5800 w.

†2852. Has Immigration Increased Population? Sydney G. Fisher (The author seeks to show that the population of the United States is now less than it would have become through increase of the native population had it continued to increase at the rate it did through fifty years following the Revolution of the colonies, and had immigration been wholly prohibited. It dates the first decline in the rate of native increase from the year 1830, when the effects of immigration were first seriously felt). Pop Sci M-Dec. 5500 w.

†2887. Strikes and Lockouts in the United States from January 1, 1881, to June 30, 1894. (Tabulated statements compiled from the third and tenth annual reports of the U. S Commissioner of Labor, with deductions and comments). Bul of Dept of Labor-Nov. 6500 w.

†2888. Strikes and Lockouts in great Britain and Ireland in Recent years (Tabulated Statements compiled from annual reports of the British Board of Trade, with comment, explanation and deductions). Bul of Dept of Labor-Nov. 2000 w.

†2889. Strikes in France in Recent Years (Tabulated statements compiled from the French Office du Travail, Statistique des Grèves et des Recours à la Conciliation et à l'Arbitrage Sur-

venus Pendant l'Année, 1864, with explanations, comments and deductions). Bul of Dept of Labor–Nov. 1000 w.

†2890. Strikes in Italy in Recent Years (Tabulated Statements derived from the Statistica degli Scioperi avvenuti nell' Industria e nell' Agricoltura durante gli anni 1892 e 1893, with explanations, deductions and comments). Bul of Dept of Labor–Nov. 500 w.

†2891. Strikes in Austria in Recent Years (Tabulated summaries and statements compiled from Vol. XI of the Foreign Reports of the British Royal Commission on Labor, with explanations and comments). Bul of Dept of Labor–Nov. 500 w.

†2892. Private and Public Debt in the United States. George K. Holmes (Compiled from various sources, chiefly from Bulletins and final reports of the XIth Census, Poor's Manual of Railroads, the Manual of American Waterworks, reports of the Massachusetts gas and electric ight commissioners, and reports of the Comptroller of the Currency, and presented in tabulated form). Bul of Dept of Labor–Nov. 3800 w.

†2893. Recent Reports of State Bureaus of Labor Statistics (A digest of the reports of the state bureaus of labor statistics in Connecticut, Indiana, Michigan, Minnesota, Missouri, and Wisconsin is given, and will be followed, in subsequent numbers, by similar presentations from the reports of the bureaus in other states. As far as possible quotations have been made from the results of the original investigations conducted by the different bureaus). Bul of the Dept of Labor–Nov. 8500 w.

†2894. Report by Miss Collet on the Statistics of Employment of Women and Girls in England and Wales (Digest of a report prepared for the British Board of Trade and based upon information contained in. 1. Returns made to the labor department in 1894 by cotton, woolen, and worsted manufacturers as to the employment of married women in their mills—especially procured for this report. 2. The statistics of occupations of women and girls at different ages in urban sanitary districts with over 50,000 inhabitants—compiled from the census sheets. 3. The published returns of inquiries recently conducted on the required scale and according to uniform methods to be found in the census returns of occupations in 1891, and in the board of trade returns of rates of wages in textile trades in 1886). Bul of the Dept of Labor–Nov. 4200 w.

†2895. Employer and Employee under the Common Law. Victor H. Olmsted and Stephen D. Fessenden (The relation existing between employers of labor and their employees, as governed by common law, in the absence of legislative enactments are herein presented in a digest compiled from various authoritative sources). Bul of the Dept of Labor–Nov. 7000 w.

†2898. Results of the Behring Sea Arbitration. John W. Foster (A defence of the policy of international arbitration. Examining the origin and complications in the controversy named, and defending the course taken by our government). N Amer Rev–Dec. 4200 w.

†2899. Our Benefits from the Nicaragua Canal. Arthur Silva White (A consideration of the political aspect, and the co-related conditions of international commerce). N Amer Rev–Dec. 2500 w.

*2916. Should the Government Control the Telegraph? I. Why the Government Should Own the Telegraph. Richard T. Ely. II. The Legal Aspect of the Telegraph and Telephone Services—Essential Parts of an Efficient Postal Service. Justice Walter Clark (Both articles favor government ownership, and set forth the advantages. Reference is made to other countries showing good results of such ownership). Arena–Dec. 3800 w.

*2917. Equality of Opportunity: How Can We Secure It? James L. Cowles (Considering the making of the railways, tramways, telegraph and telephone systems of the country, free to the use of the whole people in their ordinary transactions, and supporting these great public works by the ordinary forms of taxation. The writer does not advocate so radical a change immediately, but his proposition is to work toward this by bringing the systems of public transportation and communication under the control of the post office, making ordinary travel and the ordinary use of the telephone and telegraph free, and determining the tolls charged for special services, etc. on the postal principle, adopting the lowest rates now charged for the shortest distance as the standard rate for all distances within the United States). Arena–Dec. 6000 w.

*2961. The Multiple Standard. Henry Winn (An effort to show the chief vices of money based on gold, or gold and silver, and that their remedy lies in demonetizing both and adopting the multiple standard). Am Mag of Civ–Dec. 8500 w.

*2962. The Labor Movement and the New Labor Party. H. W. Boyd Mackay (The writer claims to set forth the feelings and aims of the party. The three direct objects of the movement are given: (1) To secure to every one constant employment. (2) To secure to every one reasonable pay. (3) To secure to every one adequate leisure). Am Mag of Civ–Dec. 1800 w.

*2963 Evolution of a Wage-Standard. R. L. Bridgman (A sympathetic discussion of the subject tending to show that we are surely advancing toward that system of justice which will insure to the contributing parties a reward according to their contribution to the product). Am Mag of Civ–Dec. 6500 w.

*2964. Legal Regulation of Occupations in the State of New York. Louis Dow Scisco (Tracing the development of legislation affecting occupations). Am Mag of Civ–Dec. 2000 w.

*2965. Funding the National Debt. A Business Man's Plan. William A. Amberg (The steps to be taken and advantages of the plan). Am Mag of Civ–Dec. 1500 w.

2981. The Recovery in "Kaffirs" (Discusses the sudden turn in the market for mining shares, and its probable industrial and financial causes and significance). Bradstreet's–Dec. 7. 850 w.

MARINE ENGINEERING

Evaporative Power of the Belleville Boiler.

DISCUSSION of the merits and demerits of this boiler has been so active of late in marine circles that the following data, obtained from actual trial of boilers built for the Russian twin-screw steamer Kherson, will be considered important as bearing upon the performance of this much-debated innovation. "The ship," says *The Engineer* (Nov. 8) "is to have twenty-four of these boilers, two of which have been completed and tested at the famous marine engineering works of Maudslay, Sons, and Field. Two of these boilers have been completed, and their evaporative power tested under conditions as nearly similar to those under which they will be operated at sea as it was practicable to arrange on land.

"To enable the trials to be carried out under the nearest approachable conditions attainable on shore to those which would obtain on shipboard, the furnace backs and sides of the two boilers were built up with the same material—fire brick—as would be used when in place in the vessel. With this exception the boilers, when under steam, were subject to the influences of the surrounding atmosphere, and its condition at the times of trial, which were not altogether favorable.

"Each of the boilers tested is made up of eight elements, or tube-sections; a section consisting of twenty tubes of wrought iron, 4¼ in. in diameter outside, and about 8 ft. 6 in. long, the total heating and grate surface in both being 2,946 and 93 sq. ft. respectively. As two boilers only were under test, a temporary uptake and short funnel were fitted, the deficiency of natural draught due to this arrangement being made up by the use of a blast pipe.

"As a precautionary measure, and to ensure that all should be in order for the official trial of Friday, Nov. 1, a preliminary trial was made on the previous Tuesday. This was of six hours' duration; the results attained, which were recorded each hour of the trial,—continued from 11 a. m. till 5 p. m.,—being given in tabular form below.

Trial hours.	Coal.		Water.		Steam.
	Total burnt.	Burnt per sq. ft grate.	Total evaporated.	Evaporated per lb. of coal	Boiler pressure lb. per sq.-in.
	lb.	lb.	lb.	lb.	
End of 1st hour ..	2,016	21·36	17,700	8·78	200
,, 2nd ,, ..	4,032	21·36	36,000	8·93	,,
,, 3rd ,, ..	6,048	21·36	55,700	9·20	,,
,, 4th ,, ..	8,064	21·36	73,500	9·10	,,
,, 5th ,, ..	10,080	21·36	90,000	8·92	,,
,, 6th ,, ..	12,096	21·36	108,000	8·92	,,
,, 7th ,, ..	14,112	21·36	126,000	8·92	,,
,, 8th ,, ..	16,333	21·66	142,810	8·74	,,
,, 9th ,, ..	18,360	21·62	160,500	8·74	,,
,, 10th ,, ..	20,378	21·43	176,700	8·66	,,
,, 11th ,, ..	22,400	21·58	195,700	8·73	,,
,, 12th ,, ..	24,164	21·39	213,300	8·80	,,

"The deduction derived from these figures will be found, on examination, to give a mean of 9·7 lbs. of water evaporated per lb. of coal consumed and 11.23 lbs. of coal burnt on each sq. ft. of fire grate, the mean steam pressure attained being 197.6 lbs. per sq. in., with a blast pressure of practically 23 lbs., the mean temperature of the feed-water throughout being 64 deg. F.

"The results having been so far very satisfactory, the official trial of November 1, which was of twelve hours' duration, was entered on with confidence. The atmosphere, however, which on Tuesday had been very cold, but dry, was on Friday wet, and heavy-laden with fog at the start, but cleared up later on. At 5.40 a. m., with atmospheric temperature of 50 deg. F., fires were lighted; in 40 minutes the gages showed a pressure of 200 lbs. per sq. in. in the boilers; 10 minutes later, or at 6.30 a. m., the measurement of coal and water—for purposes of adjustment—was commenced, and continued till 8 a. m., during which time 18 cwt. of coal per hour were burnt, with a resultant evaporation of 8.8 lbs. of water per lb. of coal. At 8 a. m. the official trial was commenced, and continued without intermission till 8 p. m., the results at the end of each hour being as shown in the accompanying table, from the figures of which it will be seen that the whole twelve hours of the trial

the mean evaporation of the water per lb. of coal consumed was 8.88 lbs., and that the coal burnt per sq. ft. of grate was nearly constant throughout, it ranging from 21.36 lbs. at the start to 21.39 lbs. at the finish, and giving a mean of 21.43 lbs. burnt for the whole time. Throughout the trial the steam pressure maintained was 200 lbs. per sq. in., and the temperature of the feed-water was 54 deg. F. The fuel used was Welsh coal of only average quality, the fires being cleaned at the sixth and tenth hours. To ascertain if the safety-valves of the boilers were capable of dealing with any quantity of steam likely to be produced in them, an accumulation test was made subsequent to the trials; for this purpose the safety-valves were set to lift at 245 lbs. per sq. in. and firing resumed, when coal was burnt at the rate of from 35 lbs. to 40 lbs. per sq. ft. of grate per hour, the maximum pressure recorded by the steam gage during the hour in which the test was continued being 247 lbs. per sq. in. Throughout the twelve hours' trial of the boilers, all the coal weighed was fired, no allowance being made for cleaning or what had found its way to the ashpits through the fire bars."

These tests seem to prove conclusively that the evaporative efficiency of the Belleville boiler is high, the figures being for actual coal supplied to the furnaces, with no deductions for coal falling through the grate. It remains to be seen whether the inherent faults of the boiler, which are notable, will prove to be so great as to offset in practice its steaming efficiency.

Tubulous Boilers in the French Navy.

A PAPER by Assistant Engineer John K. Robison, reprinted from the *Journal of the American Society of Naval Engineers*, in *Engineering* (Nov. 1), gives conclusions derived from personal observations of the practical working of these boilers on vessels of the French navy, in which this type has largely replaced the cylindrical boilers used by other nations in vessels of large size.

Of the much-lauded and much-criticised Belleville boiler the author says: "The extremely small quantity of water in the boiler has made the use of an automatic feed-regulator necessary. This regulator works well when it does work, but fails to work at all often enough to destroy confidence in it. Besides, when the regulator fails to work, serious accidents often result. The amount of feed-water is so small that any failure of the regulator to act is liable to cause the water to disappear entirely from the boiler. The small quantity of water in the boiler likewise causes large variations in the steam pressure, and necessitates a larger pressure in the boiler than at the engines; that is to say, there is a reducing valve between the boilers and the engines."

"The slow circulation of the water causes the tubes to deteriorate very rapidly, if the water is not pure. The tubes of the lowest row are made very thick, but they wear out very rapidly, nevertheless, being bent after fires are lighted under the boilers two or three times.

"The system of circulation of the water causes a great deal of 'priming,' and this cannot be cured even with the use of a complicated set of baffle-plates in the steam drum of the boiler, and with the addition of a separator between the boilers and the reducing-valve. The reducing valve must also reduce the amount of water in the steam, though it has been seen that this is not the prime object of its use. It has been estimated by engineers who have worked these boilers for several years that the amount of water in the steam at the cylinders is never less than ten per cent.

"The use of the Belleville boilers was said at the outset to be sure to give a great gain in economy of fuel. In fact, many engineers still seem to think that they are not greatly inferior to the Scotch boilers in this respect. The fact is, however, that the arrangement for the combustion of the coal to take place entirely in one place has made the mixing of the gases of combustion very poor. To insure their proper mixing, all the gas from the grate should be brought together at some point before the combustion is supposed to be completed. This would correct the inequalities in the thickness of the fires on different

parts of the grate. So very poor is the mixing of the gases in the Belleville boiler that it has been found necessary to have a pump for forcing jets of compressed air in the top of the furnace, forcing the gases of combustion down towards the grate, and so promoting their thorough mixing.

"The absolute necessity of a sure-acting feed-pump has led to the use of a specially-designed pump that will always be sure to act. This result is obtained at the cost of a large amount of steam for the pumps, but the result is so necessary that it has been said that the pump is what makes the boilers."

The boiler and its numerous accessories need frequent repair, but the repairs can generally be made in a shorter time than in the boiler instalment of the older type; and the disadvantage of greater frequency is thus more or less counterbalanced.

The advantages of the boiler most appreciated by the French naval authorities are that its action is rapid in getting up steam; that its weight in proportion to steaming capacity is much less than that of boilers of the cylindrical type; that it is easier to take it out or put it into a ship, necessitating no cutting of decks; and that higher pressures can be carried with more safety than can be carried in the Scotch boiler.

Efforts towards remedying the defects of the Belleville boiler have resulted in the production of the D'Allest boiler, and the Niclausse boiler, and the author thinks that only these three have any chance of supplanting the Scotch boiler for marine use, in large ships, though for torpedo boats and vessels of small size the Normand and the Thornycroft boilers are coming more and more into use. The greatest advantage possessed by the Belleville boiler over the D'Allest is that the arrangement of the tubes in the Belleville permits them to expand more freely; but the D'Allest is somewhat lighter, though it occupies greater floor space than the Belleville. The D'Allest boilers may, however, be forced in steam generation with greater economy than the Belleville. The Niclausse boiler permits the tubes to expand with perfect freedom, and the repairs are all done from the front of the boiler, but it is not so economical a steamer as the D'Allest, which is said to be the only one of the three which equals the Scotch boiler in this respect. Many other interesting facts are given in Engineer Robison's paper, which those who desire to inform themselves further about the merits of these boilers will do well to peruse.

The Hydroplane.

THOUSANDS were amused during the last season by what was known as the 'chute" at West Brighton, a watering. place on Coney island, near New York city. People seated in a boat shot down a steep incline terminating at the surface of a still expanse of water. Upon reaching this surface, the boat with its occupants was lifted bodily from the water, and, jumping over a space of twenty-five or thirty feet., again skipped over another space, and so on, progressing by skips across the still water precisely as a flat stone thrown at an angle with the surface of water skips, till the force with which it is thrown is exhausted,

The bottom of this boat constituted a hydroplane, in the meaning of the term employed by Mr. Harvey D. Williams in *The Sibley Journal of Mechanical Engineering*, in a description of a model constructed by him to demonstrate the possibility of a self-propelling craft constructed to skip over the surface of water, instead of sailing upon it. At first the idea of such a craft might appear absurd; but a moment's reflection will enable the reader to comprehend that this principle not only can be made to furnish amusement, but might develop into an important mode of marine attack and defence. A small vessel of this kind carrying dynamite and running amuck among an enemy's fleet would be a very disturbing element in maneuvering. In these times, when new and important applications which once would have been pronounced "absurd" are a matter of almost daily record, we must be careful not to use the word too freely. The construction of Mr. Williams's model is very simple.

"A paper-board tube forming the body of the craft conceals the motive power,

which consists of short rubber bands capable of stretching 1 ft. This motion of the rubber bands is multiplied to 6 ft., and the force is correspondingly reduced by means of a miniature rope tackle consisting of a silk cord passing to and fro six times through the tube around small box-wood pulleys and thence out of the rear end of the tube, where it winds around a drum $\frac{3}{8}$-in. in diameter. The ends of the drum shaft are bent to form two cranks 180° apart and 2″ radius. Two slightly spoon-shaped paddles, made of sheet aluminum, are carried by the cranks, the upper ends of the paddles being constrained by two bamboo connecting rods. Fastened underneath the paper tube are two planes, $15'' \times 2_{\frac{3}{8}}''$, which are placed equidistant from the center of gravity and inclined upward and forward at an angle of 6°.

"When placed in the water, the model sinks to about the middle of the tube, and, on releasing the paddles, it moves rapidly forward, raising itself until planes are on the surface, where it skims along in a straight line a distance of 40 or 50 ft. Waves of length less than one-half or one-third the length of the model appear to have little effect on its working, and ripples are rather beneficial than otherwise. They assist by catching the air and carrying it under the planes, where it spreads out into thin bubbles, thus materially reducing the skin resistance. It is only when the waves become so large that the craft is unable to preserve its horizontal position that the speed is noticeably effected.

"This principal resistance encountered by the hydroplane is the skin resistance, the wave-making and eddy resistance being reduced to almost nothing. When we recall that the resistance of ships at from twenty to twenty-five miles per hour is due one-half to skin resistance and one-half to wave-making, we can form some idea of the saving that may possibly be effected by largely doing away with the latter." Without following Mr. Williams in detail through his general remarks upon the subject of wave-making by vessels, skin friction, etc., we will simply state his conclusions (based on the experiment) that a high speed can be attained in such a craft, with properly-designed engines and machinery, and that a "hydroplane with energy enough to skim the surface of the water has more than enough energy to attain that condition from a position of rest where it floats in the water."

Waste and Supply of Shipping.

SOME interesting statistics compiled from "Lloyd's Registry" are given in *Engineering* (Oct. 11), relating to the continuous wearing out of shipping in service. The current supply not only must meet this waste, but must also provide for the general growth of marine commerce. During the single quarter of a year ending Sept. 30, two hundred and eight vessels of a total carrying capacity of 143,594 tons have been either lost or broken up, while on the other hand one hundred and fifty-nine vessels, having a total capacity of 290,330 tons, have been launched for merchant service. Decrease in number of launches and a very marked increase of tonnage are thus made apparent as a tendency of the period.

This tendency is regarded as fully accounting for the slow recovery of freights. Moreover, there is no present indication of any abatement of activity in ship-building. The ratio of the number of sailing vessels to that of steam vessels is small.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*2493. The Cunard Liners "Sylvania" and "Corinthia" (Full illustrated description, with two full page inset of engravings containing deck plans, vertical, longitudinal and cross sections, and other details). Engng–Nov. 1 2000 w.

*2495. Tubulous Boilers in the French Navy. John K. Robison (From the Jour. of the Amer. Soc. of Naval Eng. A general discussion of this class of marine boilers which shows that some of their advantages are yet off-set by grave defects. The three principal types discussed are the "Belleville," the "D'Allest," and the "Niclausse";

We supply copies of these articles. See introductory.

but something is also said of the Thornycroft, Normand and Lagrafel boilers. The first three named are regarded as the only ones having any chance of superseding the Scotch boilers). Engng-Nov. 1. Serial. 1st part. 3000 w.

*2525. Messrs. Bow, McLachlan and Company's Thistle Works, Paisley (Illustrated description of one of the most important English marine engineering establishments). Eng, Lond-Nov. 1. 3600 w.

2558. Twin Screw Steamships "North West" and "North Land" (Description of engines with illustrations showing details). Am Mach-Nov. 14. 500 w.

2579. Performance of the Steamer "City of Lowell." James E. Denton (An account of tests of performance. Condensed from a paper read at the N. Y. meeting of the Soc. of Naval Arch. & Marine Engineers). Eng News-Nov. 14. 1500 w.

2619. The Ventilation of the Boiler Room. From *Army & Navy Journal* (Proposes a change from the existing system based on the principle that each man must be his own refrigerator. Comparatively dry air is directed upon the nearly nude bodies of the men in order that perspiration may be rapidly vaporized and cooling produced). Am Eng & R R Jour-Nov. 14. 1400 w.

*2628. Steam Launch "Dragon Fly," for English Canal Inspection (A minute, detailed, illustrated description of a steamboat specially designed for inspection of narrow canals in England). Eng, Lond-Nov. 8. 1600 w.

*2632. The Belleville Boiler and Its Evaporative Efficiency (Evaporation results as taken from records of performance on the Russian Volunter steamship Kherson. Mean evaporation per lb. of coal burned was 8 88 lbs. Welsh coal of only average quality was used). Eng, Lond-Nov. 8. 900 w.

*2671. The Hydroplane. Ill. Harvey D. Williams (Describes an experiment demonstrating the possibility of a craft that will propel itself on the surface of water after the manner of a skipping stone). Sib Jour of Engng-Nov. 1200 w.

*2741. The History of Steamships. A. E. Seaton (A very interesting lecture delivered at a technical school). Prac Eng-Nov. 15. 1800 w.

*2742. The United States Cruiser "Minneapolis" (Full detailed illustrated description. Two-page inset of engravings). Engng-Nov. 15. 2800 w.

*2745. The Growth of the Port of Harwich. William Birt (Paper read before the British Asso. at Ipswich. Historical account of a port that has become important only during the last thirty years, but from which now sail, daily, passenger steamers to the Hook of Holland and Rotterdam and Antwerp; freight steamers to Rotterdam four times a week; steamers to Esbjerg three times a week; and steamers for freight and passengers to Hamburg twice a week. It is also the headquarters of the Royal Harwich Yacht Club). Eng-Nov. 15. 4500 w.

*2793. The Torpedo-Boat Destroyers "Rocket," "Shark," and "Surly" (Illlustrated detailed description). Engng-Nov. 22. 1600 w.

*2798. Marine Engineering Research (An argument in favor of such researches by scientific societies, and an account of researches upon Howden's system of forced draught. The assertion is made that the whole question of marine engineering, testing and trial has assumed, during the last few months, a national importance of the most pressing nature). Engng-Nov. 22. 1600 w.

*2799. Water-Tube Boilers. Hiram S. Maxim (The way circulation takes place in U-shaped tubes with heat applied at the bend). Engng-Nov. 22. 900 w.

*2800. Water-Tube Boilers. William Doxford & Sons, Limited (Practical experiences with the "Yarrow" boiler). Engng-Nov. 22. 500 w.

*2801. Water-Tube Boilers. A. F. Yarrow (A reply to criticisms made by M. Normand). Engng-Nov. 22. 500 w.

2817. Our Mercantile Marine (Editorial review and criticism of the U. S. Commissioner's report of navigation). Sea-Nov. 28. 1300 w.

*2819. The Application of the Law of Similarity to Marine Propellors. J. Denholm Young (Abstract of paper read before the North-East Coast Institution of Engineers and Shipbuilders. An exhaustive review of principles and practice in the construction of screw propellers, in which the topics treated are 1. Indicated horse-power and thrust. 2. Slip. 3. Wake. 4. Immersion of propellors. 5. Frictional resistance of screws. 6. Edge or head resistance of screws. 7. Centrifugal action. 8. Maximum thrust. 9. Different forms of screws. 10. Shape of blades. 11. Number of blades. 12. The turbine propeller. 13. Hydraulic propulsion. 14. Paddles. 15. Methods of procedure. 16. General considerations. An appendix is supplied, which contains a reduction of Mr. Froud's Constants under the law of comparison). Ind & Ir-Nov. 22. 4000 w.

2956. Our Navy (Summary of report of U. S. Sec. of the Navy, reprinted from New York *Journal of Commerce*). Sea-Dec. 5. 1100 w.

*2960. Shipbuilding on the Thames (Proposes to describe in a general way, the notable shipyards on the Thames, beginning in the first part with the yards of Messrs. Yarrow and Co). Ir & St Tr Jour-Nov. 23. Serial. 1st part. 1800 w.

2979. The Water-Tube Boilers of the steamer Zenith City. Ill (This steamer is equipped with water-tube boilers, and is claimed to be carrying a ton of freight at a higher rate of speed, and with less consumption of coal than any other steamer on the lakes. Description). Eng-Dec. 7. 1300 w.

*2991. Development of the Marine Boiler. J. M. Dewar (Takes the ground that the present form of marine boiler is doomed to extinction and that the water-tube boiler is the coming type). Prac Eng-Nov. 29. Serial. 1st part. 3500 w.

*2996. Admiralty Contracts (A severe criticism of the business methods of the British admiralty exemplified by some recent transactions). Engng-Nov. 29. 1700 w.

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Exhaust-Nozzles and Smoke-Stacks for Locomotives.

A PAPER on the most advantageous dimensions for locomotive exhaust pipes and smoke stacks was recently read before the German Society of Mechanical Engineers, by Herr Troske, a translation of which is printed in the *American Engineer and Railroad Journal*. The following abstract of this paper is a historical sketch of the origin of the exhaust-nozzle, comprising also the principles that should govern its construction and design.

Soon after the construction of the first railway, experiments were instituted for the purpose of heating the exhaust-nozzle in the most efficient position; and it is well known that Stephenson owes his victory in the locomotive contest at Rainhill, in 1829, to the fact that he was the first to make an application of the exhaust-nozzles to boilers for inducing a greater draft. Pambour, in 1836, was the first to institute a systematic series of experiments. He made, however, only a few, and the results that he obtained are of no great value. Nevertheless, Pambour set forth the proposition that the exhaust-pipe pressure varies directly as the speed of the piston and the generation of steam per hour, and, therefore, inversely to the sectional area of the pipe itself. He considered that the pressure in the exhaust-pipe was the same as the back pressure upon the pistons, until, in 1847, it was proven by Gouin and Le Chatelier that this is not the case. Among the French engineers who busied themselves with this question at the time was Polonceau. He made some special experiments with exhaust-nozzles of various sizes.

Clark first threw light on these subtle relationships by means of his very important and thorough investigations, made in 1850 upon a large number of locomotives. From them the following results were obtained:

1. The vacuum in the smoke-box stands in direct relationship to the pressure in the exhaust-pipe. That is, the vacuum expressed in inches of a water column gives the pressure in the exhaust-pipe in inches of mercury:

$$\frac{\text{Vacuum in smoke-pipe}}{\text{pressure in exhaust-pipe}} = \frac{1}{13.6}$$

or, say, $\frac{1}{14}$.

2. The draft-creating properties of the exhaust are dependent, first of all, upon the form and size of the stack and the position of the nozzle. Above all does the height of the exhaust-opening and the diameter of the stack influence in this matter.

3. With each stack there is some maximum size of exhaust-nozzle that will produce the best results. For a given boiler there is only one diameter of stack that is most efficient; for all other diameters the nozzle must be contracted.

4. The best position for the exhaust-nozzle is that from which the steam will be blown vertically into the stack. Hence the center line of the nozzle must coincide exactly with that of the stack.

5. The products of combustion must be able to enter the stack easily, either by making the bottom bell-shaped, or, better still, by locating the exhaust-opening at a distance below the top of the smoke-box about equal to the diameter of the stack.

The exhaust will thus be always blown through and through the products of combustion, and not merely over the top of the same. A straight vertical exhaust-pipe is, therefore, greatly to be preferred to the crooked pipe formerly in general use, since it offers less resistance to the steam as well as to the gases in their passage to the stack.

6. The proper sectional area of the exhaust-nozzle is dependent upon the great area, the sectional area of the tubes, the diameter of the stack, and the size of the smoke-box.

The larger the grate area and the sectional area of the tubes in the fire-box

tube-sheet, and the smaller the diameter of the stack and the size of the smoke-box, the larger it is possible to make the nozzle.

7. In order that a stack may work at its maximum efficiency, it must have a length that is, approximately, four times its diameter.

8. The smallest sectional area of stack which was observed was one-fifteenth of the grate area, and this permitted the use of a larger exhaust-nozzle than any other larger stack. So that these observations are taken to indicate that this proportion (one-fifteenth) is the most efficient.

9. The exhaust-nozzle may have a sectional area equal to from one-sixth to one-ninetieth of the great area, provided that the sectional area of the tubes in the fire-box tube-sheet shall be made from one-fifth to one-tenth of the grate area.

10. The vacuum in the fire-box is from one-third to one-half of that in the smoke-box.

It should be remarked just here that the English locomotives of those days had very small grates. whose area did not average more than twelve sq. ft.; hence, rules 9 and 10 cannot be applied to locomotives of the present day. Furthermore, rule 3, and the second paragraph of rule 6, in which it is stated that the exhaust-nozzle can be enlarged as the diameter of the stack is made smaller, cannot be applied in their general construction to locomotives. According to the Hanover experiments, the vacuum can be increased by making the diameter of the stack less. With this, if the original vacuum is to be retained, the nozzle may be enlarged, which will result in the lowering of the pressure in the exhaust-pipe and the back-pressure upon the piston; but this enlargement of the nozzle must take place between narrow limits; else, the combustion will be poor and the coal-consumption increased. For this reason, then, it will be inexpedient to use the small size of stack that would permit the largest nozzle to be used.

Herr Troske asserts the belief that as large a smoke-stack as is possible is always desirable, and he emphasizes the importance of rules 2 and 5, above given. He also criticises Zeuner's rules of later date. The paper is of interest and value to designers of locomotives and others who desire to know the "true inwardness" of this vital part of a locomotive.

Steam-Boiler Efficiency.

PROFESSOR A. HUETT, of the Royal Polytechnic School, Delft, Holland, is credited by M. Westerbaan Muserling (*Engineering*, Nov. 1), with having introduced what is known as the "*chain rule*," for controlling the chief data in the designing of any steam boiler. The rule is written as follows:

lb C.	a	1 G. S.
G. S.	1	b. H. S.
H. S.	1	c. lb. W.
lb. W.	d	1 lb. C.

$$a.\ d. = b.\ c.$$

In this rule a stands for pounds of coal (lb. C.) burnt per hour, per sq. ft. of fire-grate surface (G. S.); b represents the ratio of boiler-heating surface (H. S.) to fire-grate surface; c symbolizes pounds of water evaporated per hour (lb. W.), per sq. ft. of boiler-heating surface; and d stands for pounds of water evaporated per pound of coal. The necessary connection between these quantities is shown for any boiler by setting the numerical values of the symbols in the middle columns in the above exemplified form. The continued product of the terms in the first of the inner numerical columns should be theoretically equal to the continued product of the terms of the second numerical column; and from the resulting equation the value of either a, b, c, or d may be obtained in terms of the other quantities, or numerically when the numerical values of the other quantities are substituted for them in the equation.

Mr. Muserling shows, by the application of the rule to experimental results obtained by Mr. Bryan Donkin from twenty-one different boilers, that the rule is a most efficient check on experimental results, as well as an aid in designing. The examples of this application to Mr. Donkin's experiments are so instructive and interesting that we present them herewith. The agreement is surprisingly close, except in one

case—No. XVI,—in which there is a wide discrepancy. The small inaccuracies in the others are well within the limits of experimental errors. Thus the validity of the rule for the generality of cases is experimentally proved.

I.—*Vertical Boiler.*

lb. C.	17.9	1	G.S.
G.S.	1	73.4	H.S.
H.S.	1	2.33	lb. W.
lb. W.	9 57	1	lb. C.

171.30 = 171.02

II.—*Lancashire Boiler. Galloway Tubes.*

lb. C.	10.20	1	G.S.
G.S.	1	38.8	H.S.
H.S.	1	2.62	lb. W.
lb. W.	9 92	1	lb C.

101.18 = 101 66

III.—*Lancashire Boiler. Galloway Tubes.*

lb. C.	18.5	1	G S.
G.S.	1	38 8	H.S.
H.S.	1	4 78	lb. W.
lb. W.	10.02	1	lb. C.

185.37 = 185.46

IV.—*Locomotive Boiler. Wet Firebox.*

lb. C.	7.93	1	G.S.
G.S.	1	21.7	H S.
H.S.	1	3 47	lb. W.
lb. W.	9 55	1	lb. C.

75.73 = 75.30

V.—*Locomotive Boiler. Wet Firebox.*

lb. C.	6.25	1	G.S.
G.S.	1	30.8	H.S.
H.S.	1	1.72	lb. W.
lb. W.	8.45	1	lb. C.

52.81 = 52.98

VI.—*Water-Tube Boiler. Syst. de Nayer.*

lb. C.	14.3	1	G.S.
G.S.	1	31.5	H.S.
H.S.	1	4.49	lb. W.
lb. W.	11.35	1	lb. C.

162.31 = 141.44

VII.—*Water-Tube Boiler. Syst. de Nayer.*

lb. C.	14 7	1	G.S.
G.S.	1	31.5	H.S.
H.S.	1	4.26	lb. W.
lb. W.	11.08	1	lb. C.

162.88 = 134.19

VIII.—*Cornwall Boiler. Galloway Tubes.*

lb. C.	6.86	1	G.S.
G.S.	1	33.3	H.S.
H.S.	1	2.34	lb. W.
lb. W.	11.4	1	lb. C.

78.20 = 77.92

IX.—*Lancashire Boiler. Galloway Tubes.*

lb. C.	16.0	1	G.S.
G.S.	1	44.6	H.S.
H.S.	1	3.87	lb. W.
lb. W.	12 4	1	lb. C.

198.40 = 172.60

X.—*Lancashire Boiler. Galloway Tubes.*

lb. C.	16.8	1	G.S.
G.S.	1	44.6	H.S.
H.S.	1	4.20	lb. W.
lb. W.	12.46	1	lb. C.

209.33 = 187.32

XI,—*Locomotive Boiler. Stationary Type.*

lb. C.	12.4	1	G.S.
G.S.	1	32.6	H.S.
H.S.	1	4.05	lb. W,
lb. W.	10.78	1	lb. C.

133.67 = 132.03

XII.—*Elephant Boiler. Three Bouilleurs.*

lb. C.	11.04	1	G.S.
G.S.	1	23.5	H.S.
H.S.	1	4.89	lb. W.
lb. W.	11.7	1	lb. C.

129.17 = 114.92

XIII.—*Locomotive Boiler. Goods Tank Engine.*

lb. C.	35.5	1	G.S.
G.S.	1	69.2	H.S.
H.S.	I	2.05	lb. W.
lb. W.	12.18	1	lb. C.

432.39 = 432.50

XIV.—*Locomotive Boiler. Goods Tank Engine.*

lb. C.	28.1	1	G.S.
G.S.	1	69 2	HS.
H.S.	1	5.1	lb. W.
lb. W.	12.51	1	lb. C.

351.53 = 352.92

XV.—*Locomotive Boiler. Goods Tank Engine.*

lb. C.	31.7	1	G.S.
G.S.	1	69 2	H.S.
H.S.	1	5.62	lb. W.
lb W.	12.29	1	lb. C.

389.59 = 388.90

XVI.—*Fire Engine Boiler. Horizontal Tubes.*

lb. C.	34.3	1	G.S.
G.S.	1	45	H.S.
H.S.	1	13.1	lb. W.
lb. W.	7.95	1	lb. C.

272.69 = 589.50

XVII.—*Cornish Boiler. Multitubular Type.*

lb. C.	13.7	1	G.S.
G.S.	1	54	H.S.
H.S.	1	2.52	lb. W.
lb. W.	9.91	1	lb. C.

135.77 = 136.08

XVIII.—*Locomotive Boiler. Portable Engine.*

lb. C.	10.8	1	G.S.
G.S.	1	27.2	H.S.
H.S.	1	3.85	lb. W.
lb. W.	9.57	1	lb. C.

103.36 = 104.72

XIX.—*Cornish Boiler. Galloway Tubes.*

lb. C.	15.7	1	G.S.
G.S.	1	19.3	H.S.
H.S.	1	7.43	lb. W.
lb. W.	9.16	1	lb. C.

143.81 = 143.40

XX.—*Cornish Boiler. Multitubular Type.*

lb. C.	21.5	1	G.S.
G.S.	1	40.2	H.S.
H.S.	1	5.42	lb. W.
lb. W.	10.15	1	lb. C.

218.23 = 217.88

XXI.—*Locomotive Boiler. Stationary Type.*

lb. C.	25.5	1	G.S.
G.S.	1	37.4	H.S.
H.S.	1	7.23	lb. W.
lb. W.	10.64	1	lb. C.

271.32 = 270.40

Mechanical Flight.

A SUFFICIENTLY exhaustive review of progress in this field of mechanical engineering (not too technical for the majority of readers interested in the subject) is printed in No. 8 of *Papers Read before the Engineering Society of the School of Practical Science*, Toronto. The paper is written from the standpoint that mechanical flight is soon to be an accomplished fact with which engineers will have to deal, as they now deal with locomotive and marine engineering; and, though this may be an over-sanguine estimate, the progress that has actually been made, as shown by the author of the paper, Mr. C. H. Mitchell, is really greater than is popularly supposed. Past failures are attributed mostly to the crude attempts of mechanics without scientific knowledge to guide their efforts; but, now that the scientific principles underlying flight are gradually being unfolded, the subject takes on a very different aspect. An attempt to give here an idea of all the information collected from a great variety of sources and presented in this paper would be vain; those interested in this line of study and invention should consult the article itself. The paper is confined to aviation as distinguished from aerostation, and it is predicted that all future progress will be in the direction of aviation—defined as being the navigation of the air by machines heavier than air.

Worm Gearing.

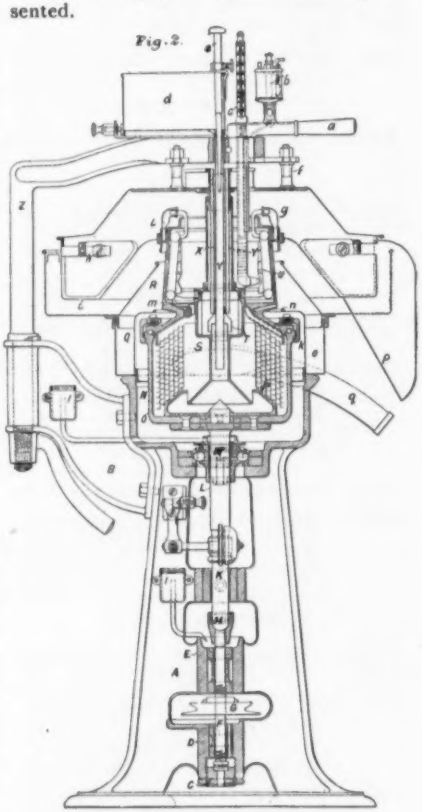
THIS much-criticised mechanical device is beginning to find defenders. It is now claimed by many good mechanical engineers that its defects have hitherto been due to want of skill in design and in application, and that such defects are not inherent. *The Mechanical World*, referring to experiments of Towne, Sellers, Reckenzaun, and others, says these experiments have shown that the device is capable of much more service than has hitherto been credited to it. Professor Stodola has also been experimenting with it. The worm used by him was 3⅛ in. in diameter, and "it engaged with a worm wheel having 28 teeth, the wheel being of bronze, 14¼ in. in diameter. The whole of this gear was placed in oil in a cast-iron box. The gear was coupled to a 20 h. p. electric motor, and the braking tests were made on the worm-wheel shaft. At 1,500 revolutions, a useful performance of 21 h. p. was given on the brake, the efficiency amounting to 87 per cent." It is believed that the efficiency may be increased to 83 per cent., if

the following rules are regarded: "The starting speed should, according to the output, amount to from 20 to 40 ft. per second, instead of from 7 to 16 ft., as has hitherto been customary. This condition necessitates the use, not only of high motor speeds, but also of a large diameter of worm, and consequently great distances between the teeth, powerful teeth, and ample bearing surface. By this means the total friction will be reduced. For driving elevators the motors required range from 2 to 25 h. p., with usual speeds varying between 1,600 and 800 revolutions a minute. As the elevator drums to be operated, the driving spindles of machine tools, and the car axles of tramcars, have speeds of from 150 to 40 revolutions a minute, it is possible to obtain in the most simple manner, without any intermediate gear, the whole speed reduction by means of worm gearing, with a single- or double-thread worm having a ratio of reduction of 10 to 1 or 20 to 1." The construction of this kind of gearing for direct coupling requires great care. The worm should be of tool steel, accurately fitted, tempered, and polished, and the wheel should be of bronze. The friction while running in oil may thus be reduced very greatly.

A New Swedish Butter-Making Machine.

THE fame of the Swedish "separator," for separating cream from milk almost immediately after milking, is world-wide. In this machine, which is an admirable example of fine mechanical construction, advantage is taken of the small difference between the specific gravity of cream and skimmed milk, the separation being effected by centrifugal force in a rapidly-whirling mass of the liquid. Simple as is the principle, the mechanical difficulties in practically carrying it out, in such manner as to render it generally available in dairy countries, have been greater than could be imagined by any one not acquainted with them. In this machine, and in all devices of mechanical engineering for the treatment of milk and dairy products, Sweden has taken the lead, and a Swedish inventor now again comes to the fore with a machine for not only separating the cream from the milk in a brief time, as does the machine previously mentioned, but for converting the cream immediately into butter, without further handling. This machine is so ingenious in construction, and affords so good a mechanical study, that a vertical section illustrating its parts and their arrangement, and an abstract of a description from an article in *Engineering* (Oct. 4), are herewith presented.

Fig. 2.



SWEDISH BUTTER MAKER.

The machine is mounted on a frame much like an ordinary separator, the vertical spindle *L* being supported in a footstep and by side, anti-friction bearings, *K* and *M*; near the bottom of the shaft is the pulley, *G*, by which a rapid motion is imparted to the shaft. On the top of the latter is the cream skimmer, *N*, and above it is the churn, *R*. This latter is con-

nected to the former by an easily-detachable joint, and there is free communication between the two. The whole milk is delivered down the central tube, *B*, and falls down into the skimmer through the cone, *S*, which lies within a concentric cone, *O*, that serves to distribute the milk in the separator. The separating and churning chambers are driven with a velocity of about 6000 revolutions per minute, which causes the cream to rise up the sides of the radiator in the usual way. A part of the cream, urged upwards, passes through the churning tube, *Y*, part of which is perforated with a series of very fine holes, through which the cream is driven by centrifugal force with great velocity against the cream rising in the churn; the effect of this contact is to convert the cream almost instantaneously into butter, which passes through the opening in the top of the churn, and is removed by an automatic scraper. The skimmed milk flows off in the usual manner through the spout, *q*. A complete system of water circulation cools the cream and maintains it at the most effective temperature. The buttermilk issuing with the butter is collected and passed again through the churn.

In the complete installation of the system, the milk, collected from a group of dairies within a convenient radius, is delivered into a tank, and lifted by a pump into a pasteurizing tank, where it is heated to a temperature sufficient to sterilize it. The milk is then allowed to flow at a suitable rate into the radiator bowl, and forced into the churn, where it is immediately cooled by ice-cold water circulated from the tank, *i*, by a rotary pump, *G*, through the circulating tubes of the churn. The skimmed milk rises from the separator, and flows through a pipe into a cooler, outside of and separate from the machine.

This apparatus, invented by Mr. Gustaf Salenius, and called a combined cream separator and radiator churn, is in use in a number of European dairies, and it has been warmly approved by the department of agriculture in France; the size chiefly in use can deal with upwards of 180 gallons of milk per hour. In Sweden some of the dairies where it is employed are worked on the coöperative system. Each farmer brings his greater or smaller quota of milk, the butter-making value of which is tested in advance, and receives a credit note for the amount of butter that the milk contains. The deliveries are afterwards all mixed, and each farmer receives his proper proportion of skimmed milk, the account for butter being settled periodically. The same system of collection and coöperation prevails in the dairy regions of the United States.

It is claimed that butter made in this manner is of the finest quality, and that it keeps much better than butter made by previous methods.

Probably the reasons for this fact are that the rapidity with which the butter is made does not allow time for incipient chemical changes; and that the separation of the buttermilk from the butter is more complete than with butter churned in mass and having the buttermilk worked out by hand.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Technical Journals—See Introductory.

The Machine Shop.

2548. Compressed Air in Railway Shops. Ill. (Will present in this and subsequent parts, answers to the following questions sent out in a circular letter, by the Railway Age, to one hundred of the principal railway shops in the United States. 1. To what extent do you make use of compressed air in your car and locomotive shops? Please name tools and appliances and number of each in use. 2. What apparatus do you use for compressed air (special compressors, locomotive air pumps, or home made devices? 3. If locomotive air pumps are used, how many are required for your purposes and of what size are they? 4. What pressure of air per square inch do you use? 5. What pressure of steam is used to operate the air pumps? 6. How much steam of this pressure is required to compress one cubic foot of free air to the pressure named in answer to question 4? 7. Do you consider the locomotive air pump an economical means for compressing air for shop purposes? Please give reasons for your opinion. 8. In what line do you find the greatest economy to be developed from the use of compressed air for shop purposes)? Ry Age —Nov. 8. Serial. 1st part. 4800 w.

We supply copies of these articles. See introductory.

2559. The Test of Roller Bearings. T. W. R McCabe, and George B. Woodruff (Details of tests made by the authors with shafting, both with and without roller bearings (Am Mach-Nov. 14. 900 w.

2560. Tests of Leather Belting. Charles H. Benjamin (These tests relate to the strength and elasticity of belting, without reference to strength of lacings). Am Mach-Nov. 14. 900 w.

2672. Some Uses of Cross-section Paper in the Machine Shop. William O. Webber (Containing practical suggestions relative to the use of cross-section paper, in keeping the run of shop expenses and estimating cost of jobs). Am Mach-Nov. 21. 1100 w.

2774. Setting a Milling Cutter—Boring and Inside Threading Tools—Making Soft Metal Molds. A. H. Cleaves (A suggestive and instructive practical article). Am Mech-Nov. 28. 2300 w.

2775. Neglected Possibilities of the Modern Machine Shop (Editorial suggestions on planning, arranging and equipping). Am Mach-Nov. 28. 700 w.

*2797. The Position of Draughtsmen (Editorial review of an address upon the subject of training engineers, delivered by Mr. Archibald Denny at the Institution of Junior Engineers). Engng-Nov. 22. 3000 w.

2836. Locomotive Cylinders. Herbert M. Ramp (Full directions, illustrated by engravings, for performing a difficult class of foundry work). Foundry-Nov. 2000 w.

2949. Data Relating to Forge-Shop Design. Paul M. Chamberlain (Illustrated description of forge shop in the mechanical department of Michigan Agricultural College with special reference to air-blast and suction for smoke expulsion). Ir Tr Rev-Dec. 5. 700 w.

*2989. Defects in Iron Castings. D. Brown (The variety of causes inherent in materials and workmanship, and the remedies). Prac Eng-Nov. 29. 2200 w.

*2990. The Construction of Worm Gearing. Ill. Herbert Aughtie (Calls attention to some points not too obvious to ordinary mechanics). Prac Eng-Nov. 29. 1100 w.

Steam Engineering.

*2494. Steam Boiler Efficiency (Rules for designing steam boilers and checking experimental determinations of efficiency, enunciated by Prof. A. Houet, of the Royal Polytechnic School of Delft, Holland, and communicated by M. Westerbaan Muserling). Engng-Nov 1. 300 w.

*2521. Steam Engine Economy: Condensing Engines. Henry Davey (A paper read before the Inst. of Civ. Eng. Treats of a method—not in common use—for examining results of engine tests, and which is substantially a comparison of indicator diagrams, with ideal theoretical diagrams at the same point of cut off). Col Guard-Nov. 1. 4000 w.

2609. Clean Boilers. F. T. (Treats of the practical use of kerosene as a material for cleaning and keeping boilers clean). Lord's Mag-Nov. 2000 w.

*2610. Internal Friction in Steam Engines. Walter William Houfe (Read at the Inst. of Marine Engs., Stratford. Regards what is called "cutting" in steam cylinders as more properly described by term abrasion, and seeks causes and remedies for this action. First part treats of causes). Marine Eng-Nov. 1. Serial. 1st part. 1900 w.

2643. Steam Engine Economy: Condensing Engines (Interesting and very full discussion by members of the Inst. of Civ. Engs., drawn out by the reading of a paper by Henry Davey, indexed above). Col Guard-Nov. 8. 9000 w.

*2665. The Accuracy of Valve Gears. Digna Sequamur (A criticism of terms in which the action of steam engine valves is generally stated). Engng-Nov. 8. 1500 w.

*2670. The Method of Initial Condensation and Heat Wastes in Steam Engine Cylinders. R. H. Thurston (Abstract from a paper read at the 36th session of the Inst. of Nav. Arch. An account of a preliminary study of the facts of the case, illustrated by the action of several different classes of engines with equations and diagrams). Sib Jour of Engng-Nov. 5800 w.

2673. Crank Shafts of Single-Acting Engines. W. H. Booth (An argument sustaining Wöhler's law of stresses and asserting this law is ignored in the design of crank-shafts). Am Mach-Nov. 21. 900 w.

2724. Economy in Compound Engines (The "Rockwood" system of proportioning cylinders. Principles underlying the system explained. A description of the system and a statement of advantages claimed for it). Bos Jour of Com-Nov. 23. 1200 w.

*2808. Internal Engine Friction (Editorial review of Walter W. Houfe's paper, elsewhere indexed. The paper is criticised as advancing a plausible theory, but as not covering the whole ground). Eng, Lond-Nov. 22. 1800 w.

2841. Test of the Detroit Pumping Engine (Report of George H. Barrus, with diagrams of steam engine performance, and tables of data and results). Eng Rec-Nov. 30. 6400 w.

†2876. Some Preventable Wastes of Heat in the Generation and Use of Steam. William Kent (A lecture delivered before the Franklin Institute. The subject is well covered but the lecture contains little that is new). Jour of Fr Inst-Dec. 4500 w.

2940. The Reliability of "Throttling Calorimeters." James E. Denton (Shows that the use of small throttling calorimeters, in testing the quality of steam, is unreliable unless used in conjunction with a separator to eliminate water from the steam and uniting determinations of drip from the separator, with those of the calorimeter). Eng News-Dec. 5. 1100 w.

*2987. Trial of a Pair of Beam Engines, Working Compound, Cylinders Steam Jacketed (Description of boilers and of the engine tests, and conditions under which the latter were performed with tabulated results and numerous engine diagrams). Prac Eng-Nov. 29. 2800 w.

Miscellany.

2490. Crude Petroleum for Fuel. George H. Larkin (Report of tests made by the writer, under horizontal return flue tubular boilers at

the works of the Pacific Rolling Mills, San Francisco, using the Union Oil Company's standard 23 degree gravity fuel oil from the Santa Paula (Cal.) oil fields, fed through the Larkin oil burner). Jour of Elec–Oct. 1200 w.

*2496. Carbonic Anhydride Refrigerating Machines. E. Hesketh (Paper read before the British Asso. at Ipswich. Illustrated detailed description of a new English compression machine for liquefying carbonic anhydride for refrigerating purposes). Engng–Nov. 1. 3800 w.

2557. Some Recollections of Machine Shops in the Early Forties. Washington Jones (These reminiscences will be interesting to all mechanical engineers, especially so to the older members of the profession who have lived to see the enormous progress made since the period named). Am Mach–Nov. 14. 1700 w.

2613. Methods of Heat Insulation (Discusses the subject generally and follows with a consideration of asbestos as an insulating material, and methods of using it for this purpose). Ir Tr Rev–Nov. 14. 2000 w.

2618. The Most Advantageous Dimensions for Locomotive Exhaust-Pipes and Smoke-Stacks. Inspector Troeke (The question is discussed from the practical consideration of most effective draught. The first number gives an account of Zeuner's experiments, with an engraving of the apparatus employed, and also a description of Nozo and Geoffroy apparatus for testing draught efficiency). Am Eng & R R Jour–Nov. 14. Serial. 1st part. 5000 w.

*2633. Gibbs' Harvest Saving and Tea Drying Machines. Ill. (Interesting detailed description of a very unique machine for drying hay and other analogous farm produce). Eng, Lond–Nov. 8. 1100 w.

*2660. Combined Sleeper Adzing and Boring Machine (Illustrated description of a machine specially designed for adzing and boring seatings in sleepers of irregular form and of such hard woods as are used on the South American railways). Engng–Nov. 8. 300 w.

2667. Brakes and Fenders for Electric Cars. Oberlin Smith (Maintains that the fender problem has not been attacked from the proper standpoint. Not only protection for the body, but for the arms and legs should be provided. Gives hints). Ir Age–Nov. 21. 800 w.

2676. The Equipment of the Broadway Power Station of the New York City Cable Railroad System Stuart Thomson (General description only). Safety V–Nov. 2400 w.

†2700. Local Annealing of Hard Faced Armor Plates. Herman Lemp, Jr. (Paper read before the Amer. Inst. of Elec. Eng. with discussion. Illustrated description of the process and apparatus necessary. Experiments described, and methods formerly used explained). Trans of Amer Inst of Elec Eng–Oct. 5300 w.

*2739. Modern Gas Engines. Frederick Grover (The first part is introductory and historical). Prac Eng–Nov. 15. Serial. 1st part. 2400 w.

*2772. Machinery in South Africa (A correspondent's account of what he saw of machinery in various African mines. The Meldrum furnace and other improvements at the Robinson. Progress on the Westleigh Mines. New Machinery at the Ruby and Heriot). Mach, Eng–Nov. 15. 1600 w.

*2807. American Self-Propelled Carriages. Ill. (A statement of the conditions of the Chicago competition, and an account of the entries and results). Eng, Lond–Nov. 22. 4000 w.

2823. The Recovery of By-products from Producer Gas. A. Gillespie, in *Journal of the West of Scotland Iron and Steel Institute* (The author disclaims a knowledge of the chemical value of the by-products of producer gas, but claims that if their recovery does not reduce the heat value of the gas enough to endanger its efficiency, he can show how they can be secured, —and then proceeds to explain the method and appliances needed for the purpose). Am Mfr & Ir Wld–Nov. 29. 2000 w.

2837. Fuel Oil for Foundries (Describes and illustrates the application of a system for using oil-fuel, to core-ovens and brass furnaces). Foundry–Nov. 1000 w.

†2924. The Smoke Problem. Richard J. McCarty (One of the ablest expositions of the principles of smoke production, and of the converse smoke prevention, that has ever been printed. The author concludes that while a great mitigation of the smoke nuisance can be reached, its total suppression, in the present state of knowledge, is impracticable). St Ry Jour–Dec. 5800 w.

2926. Ball Bearings and Rubber Tires for Carriages. Ill. (From *La Nature*. Gives a sketch of the history of the introduction of these devices, dating ball-bearings back to 1857). Sci Am Sup–Dec. 7. 1000 w.

2928. The Motocycle Contest (Brief account but comprising all the essential facts of the race, and concluding with the opinion that it has greatly advanced the art in this country). Ir Age–Dec. 5. 1200 w.

2930. John Fritz, President of the American Society of Mechanical Engineers. Ill. (Biographical sketch of a representative American mechanical engineer). Am Mach–Dec. 5. 7000 w.

2931. English Smoke Consumers. W. A. Carlile (Takes the ground that English smoke consumers are for the most part more appropriately "money consumers." Causes of their inefficiency are given. Present state of the art). Am Mach–Dec. 5. 1500 w.

2932. Steel, Fire and Water (Contains valuable and practical hints on hardening and tempering). Am Mach–Dec. 5. 2400 w.

*2978. The Dessau Gas Tramcars. W. von Oechelhauser (An account of the present status of the Dessau installment and of the success reached in this method of propelling cars). Gas Wld–Nov. 30. 1200 w.

*2993. The Philadelphia Pneumatic Postal System (Descriptive The most interesting feature of the construction is the method of reducing cast iron pipe to a uniform bore by means of extemporized boring machines, having flexible boring bars). Engng–Nov. 29. 1300 w.

MINING & METALLURGY

The Rand Conglomerates.

AT the usual monthly meeting of the Geological Society of South Africa a paper was read by Mr. Kuntz on the gold-bearing formations of the Transvaal. *The Mining Journal* (Nov. 16) quotes: "Like all sediments, the schists of the so-called Cape formation are of water-worn origin, deposited during the Devonian period, near a sea coast, and were formed of the South African primary rocks and the underlying granite." After discussing the formation and folding of the schists, with the attendant effects, the author accounts for the presence of the gold in the banket as follows:

"The question touching the origin of the gold in the conglomerates is a very difficult one, and has already caused a good deal of discussion, not only among South African geologists, but among those of other countries. Their theories on this subject are very different, the three principal ones being as follows:

"1.—The gold was deposited by some chemical precipitation from sea water, simultaneously with the deposition of the conglomerates. By certain chemical actions, perhaps in consequence of the gold containing water meeting waters containing sulphates of iron or any organic substance, the gold may have been precipitated and deposited in crystalline forms in the sediments then settling down.

"2.—The gold was deposited simultaneously with the formation of the conglomerates, as is the case with alluvial gold, and then subsequently dissolved and crystallized by means of percolating solutions. When the gold was discovered to be in the form of very small and deformed cyrstals within the cement of the conglomerates, it was assumed that the gold was dissolved in place and redeposited, as was evidenced by rich chutes in quartz veins, the presence of gold in the footwall, rich smaller leaders accompanying the reefs, enrichment in smaller parts of the reefs, etc, Up to the present time no gold of primary origin has been found in the conglomerates.

"3.—The gold was not originally present in the conglomerates during the time of their deposition, but is of secondary origin. The crystalline nature of the minerals in the conglomerates, especially in the cement of them, is the most irrefutable argument for their secondary formation, whether they were originally present or not. Supposing that small hollow spaces between the pebbles remained when the conglomerates were formed, and which allowed the percolation of solutions, why, in such hollow spaces, should there not occur actions which are usual in other similar hollow spaces,—for instance, in the clefts in which veins had been formed? The minerals in veins are formed in most cases by percolating solutions. This is proved by parallel actions observed within historic times. Respecting the material forming the veins, the views of geologists are not yet in accord to-day. There are, however, two theories better recognized than the others,—the theory of 'lateral secretion,' and the theory of 'ascension,' as we call them in German. According to the first, all fillings of the veins originate from the adjoining rocks, and, according to the second, the filling material comes from below. Microscopic and chemical examinations of the vein rocks, as well as of the adjoining rocks partly decomposed along the veins, have been carried out at Freiberg, in Saxony, and Przibrane, in Bohemia, by which it has been proven that most of the minerals in the veins are contained in the undecomposed parts of the adjoining rocks also, whilst the immediately-adjoining partly-decomposed parts of the rocks are deprived of them. Considering that the percolating solutions often rise from a considerable depth, and are also percolating through rocks situated, perhaps, miles below the surface, which contain other minerals, it is quite natural to infer that these solutions

may carry with them also elements of other minerals not contained in the upper attainable rocks. Thus the process of filling the veins can be explained sufficiently by both these theories, or by 'lateral secretion' alone, taking it in a broader sense."

"The conglomerates in which the pebbles are lying immediately one on another are generally richer than those in which the pebbles are imbedded in a surrounding fine-grained cement." In other words, the richest filling of spaces was where these cavities were not filled by fine material at the time the conglomerates were deposited, implying that the gold bearing solutions came after the pebbles were laid down.

Erhardt Process for Tubular Bodies.

AMONG the United States consular reports to the department of State will be found that of United States Consul-General Frank Mason on the later metallurgical developments in Germany. *The Iron Trade Review* extracts the following information from the later of these reports: "In the work at Dusseldorf the mandrels are operated by hydraulic pressure, and are usually set in a horizontal position, though this is immaterial, the matrices being held in position in massive iron bed-frames, and carefully adjusted so that the mandrel, being steadied at the point of impact by fixed guides, shall pierce the exact center of the billet, and, by compressing the yielding metal outwardly into the space between the mandrel and the matrix, produce a hollow body the shell of which is everywhere of exact and uniform thickness.

"Both mandrel and matrix, or either of them, may be round, square, hexagonal, or of any other desired sectional shape, so that round, square, or otherwise formed tubes may be made with equal facility. Not only wrought iron and steel, but copper and other malleable metals, are worked with entire success by this process, the only requirement being that the blank billet, in the case of each different metal, shall be worked at such temperature as to secure its highest degree of malleability and ductility."

"Among the varied purposes to which the process has been applied at Dusseldorf, the two simplest and most susceptible of ready description are the manufacture of shrapnel shells for the German field artillery and steel flasks for containing liquid carbonic and other acids. Similar to the manufacture of shells, acid flasks four or five feet long by eight inches in caliber are made and shaped by a single movement of the press, without a seam or flaw, and of such quality that the thin shells sustain an expansive pressure of two hundred and fifty atmospheres. So superior, indeed, is the work turned out by this method that the German government has required the principal maker of guns and projectiles in that country to adopt the Erhardt process for the manufacture of such war material as is delivered for the use of its army and navy. The economy of the process is said to be fully fifty per cent."

The Mining Schools of Germany.

THE growing interest in mines and the revival of mining booms has affected everything in any way related, so that the technical press is taking up the discussion of mining schools, and the qualifications and duties of the professional mining engineer, with considerable interest. This is especially noticeable in English journals, as evidenced by the appearance of a report by the United States consul at Chemnitz on mining and trade schools, which was abstracted under the head of "The Mining Schools of Germany" in the *Journal of the Society of Arts* (Oct. 11), and copied from with avidity by several other journals. The fact is that English mining schools, like English methods in metallurgy, are behind the times, and the English are beginning to realize the fact. Great confusion reigns in American mining courses, and the whole world seems to look to Germany for an example of what a mining course should be. To quote from the article mentioned:

"Among the many mining schools of Europe few, if any, are superior to those of Clausthal, in the Hartz mountains, and Freiburg, in the mineral mountains of Saxony. Throughout Germany the question

of education—especally practical, technical, and industrial education—takes precedence of all others."

The establishment at Clausthal seems to be the best example to use for illustration.

"It is surrounded by mineral mountains, into which shafts have been sunk, and at whose bases are situated, in active operation, a great many smelting furnaces, machine shops, and factories. The value of these to the student is incalculable, and much of the success of the school is undoubtedly due to its favorable situation. Its origin, which dates back to the end of the sixteenth century, was due to a desire to furnish regular and exact instruction in the mathematics and mechanics necessary to the successful mining of the many metals and minerals known to be in the surrounding hills. . . . For four centuries the Hartz mountains have been worked, and at the present day, in spite of tremendous difficulties, by means of scientific methods, these mines are made profitable. The State works the mines and supports the school. Within a circle of 3 miles are the most important lead, silver, and copper mines, and the smelting works of the Upper Hartz. Some of the mines are worked to a depth of 3000 ft., with veins 150 ft. wide. One great advantage the students have is in seeing all kinds of ores smelted. Ores from all countries come from Clausthal to enter the crucibles and come out refined. The school aims at giving such a scientific technical training as will fit the students to take charge of mines and smelting works of all kinds and sizes . . . ."

There is a preparatory course beginning the week following Easter Sunday and lasting 24 weeks, and an advanced course from October to the close of July. There is a mining library of 14,500 volumes, and an additional one, at the students' disposal, of 13,500 volumes; also five hundred models, numerous charts, drawings, etc.; a chemical library and a laboratory accommodating fifty students; five hundred excellent geological cabinet specimens; collections of minerals, ores, metallurgical products, fuels; instruments used in mine surveying; and all other necessary apparatus.

Students must be at least 17 years of age. The fees are very moderate, the usual fee being 3 marks for 1 hour per week; daily work in assaying and chemical analysis, 18 marks per month.

"Students may be examined in any subject taught in the school, and in everything in mining and metallurgy. If successful, they get diplomas and certificates of fitness, signed by the proper authorities. There are examination fees of 30 marks, when three students come up at once, and 6 marks for each additional student. For the degrees of mining and metallurgical engineer, 75 marks are charged, and 60 marks, if for one of these alone,—*i. e.*, mining engineer or metallurgical engineer. The studies themselves comprise (1) trigonometry, algebra, and geometry; (2) physics, practical physics, electricity, and mechanical theory of heat; (3) chemistry, theoretical chemistry, practical work in the chemical laboratory, chemical technology; (4) mineralogy, practical mineralogy, general geology, special and practical geology, and ore deposits; (5) elementary mechanics, higher mechanics, instruction in the construction of machines; (6) concentration of ores and mining; (7) surveying; (8) metallurgy and fuels—general metallurgy, special metallurgy, lectures on fuels and metallurgy of iron; (9) blowpipe analysis and assaying; (10) general jurisprudence—historical, Roman church, German and Prussian laws, private rights, State laws, German mining laws, general doctrines, ownership of mines, mining companies, miners' customs; (11) political economy—trade statistics and administration; (12) emergency lectures—physiology and anatomy of the human body, and how to aid the injured (means, natural and artificial, general aid, aid in special cases, and transportation of the wounded). During the latest year for which returns are available it appears that, of the total number of persons attending the Clausthal School, 110 were Germans, 18 English, 1 Dutch, 13 Americans, and 11 students whose nationality was not distinguished."

As a rule American schools pay too little attention to subjects (10), (11), and (12), though President Drown, at a recent alumni banquet of one of our leading engi-

neering schools, stated that it would be the policy of his institution in future to broaden the field, especially in the direction of the "humanities" and political economics.

The Semet-Solvay Coke-Oven.

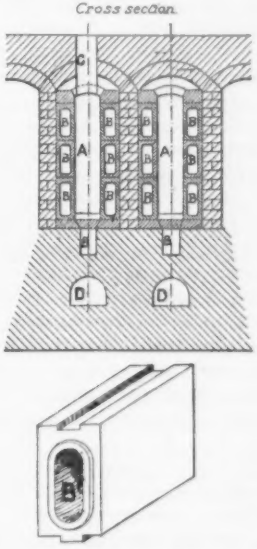
THESE ovens are in operation at Syracuse, N. Y., where they are found, according to the *Engineering and Mining Journal* (Nov. 30), far superior in various ways to the ordinary bee-hive oven. "There is no comparison between the two systems. At Syracuse, using a coal of 80 per cent. fixed carbon and ash, the Solvay ovens yield in regular work no less than 82 per cent. of good coke and 3 per cent. of 'breeze'; that is, the yield in coke exceeds the total fixed carbon plus ash, some of the volatile carbon evidently being condensed in the coking. The cost of the ovens is no greater than the bee-hive oven per ton of coke produced.

"The by-products are 45 lbs. of tar worth 18 cents per ton of Morris Run coal; 15 lbs. sulphate of ammonia; and 12,000 to 15,000 cu. ft. of 22 c. p. gas. The ovens are heated by producer gas, of which 160,000 cu. ft. is obtained per ton of coal. The by-products more than pay for the coal and the running of the producers.

"With Connellsville coke the Solvay ovens produced 15 to 20 per cent. more coke than is obtained by the bee-hive ovens, and gave about 21 lbs. of sulphate of ammonia and 100 lbs. of tar per ton of coal.

"In general arrangement the ovens are grouped together, the combustion gases being led from the side flues of the ovens through the bottom flue into a main flue, and passing from thence, through the boilers, into the chimneys. The coke is pushed out of the ovens by means of two steam rams, which are removed from one oven to another by an endless chain running along the ovens, driven by a capstan placed in the engine-house. This arrangement permits the working of all the ovens with one single ram, in case of breakdowns. These steam rams receive their supply of steam from the boilers by means of a pipe line placed along the ovens, which is connected with the rams by movable elbow-joint pipes.

"The gases disengaged from the coal during the coking process pass first into a hydraulic main put up on each set of ovens. From there they are led through wrought-iron pipes to the condensers, whence they are drawn through the exhausters, and forced through washers, back to the ovens. The peculiar construction of the hydraulic main obliges the gases to bubble through a small depth of water, whereby the cooling of the gases is greatly accelerated, and the formation of hard tar is prevented. The condensers are double jacketed, with continuous water circulation.



"The coal is charged through (C) into the coking chamber (A).

"The heating arrangement is shown in the drawing. Part of the gas is introduced in the upper range of hollow tiles (B), on the side of the steam ram (A), and, passing successively through the intermediate and lower ranges, the gas descends to the flue under the floor of the oven. Another part of the gas is introduced on the opposite side into the middle range. The object of this division of the gases is to avoid overheating certain points and to obtain a

better distribution of heat. The air needed for the combustion of the gas is admitted close to the first gas inlet, and is previously heated to a temperature of 392° to 572° F., by the brickwork under the floors of the ovens, in the following way: beneath the flues, under the floors, are channels (D) through which the air, drawn by the chimneys, is made to pass before entering the upper range of hollow tiles where the first introduction of gas takes place.

"The dimensions inside the ovens are as follows: length, 30 ft.; breadth, 1 ft. 2 in. on the side of the steam ram and 1 ft. 3 in. on the other side; height, 5 ft. 8 in. The brick walls are two bricks thick, or 16 in., and the thin sides of the tiles or retorts 3 in. The ordinary ovens have to be altogether pulled down and reconstructed after about 10 years' working, whereas with the Semet-Solvay system it is sufficient to replace the independent side flues, which does not cost more than $100 per oven.

"Every ingress of air into the ovens has been carefully avoided. The doors are designed in such a way as to enable an easy and efficacious luting. All the other openings, such as the charging shafts and the cleaning holes in the ascending gas-pipes, are closed by covers with faced joints, maintained in place by springs, thus avoiding any further luting. The coke coming out of the oven does not show the slightest trace of combustion, and thus proves that the oven is thoroughly air-tight.'

The Cause of Increased Gold Production.

MANY people are apt to look to superficial causes for the explanation of the growth of the gold-mining industry, instead of reducing the question to a basis of stern business conditions. An editorial in *The Mining Industry and Review* (Nov. 21) ridicules the statement of a contemporary that the increased production was due to the invention of new processes, and says that "it is very largely due to the unavoidable operation of one of nature's mercantile laws. That law is: when there is more than ordinary profit obtained from the production of any article, the production of that article at once increases very rapidly. . . . . Because gold mining has increased in profit year by year, it has attracted constantly increased attention from prospectors, miners, and capitalists, and the inevitable result is an increased production. Why it has increased so rapidly year by year in profit is because the product of gold mining has year by year increased in value. The ounce of gold is worth $20.67,—which is its coinage value,—and it has been the same for over fifty years. But the cost of producing the ounce of gold declines as prices fall. How much that cost has declined in a few years can be seen from a comparison of the following tables of prices of the articles which constitute the expense account in mining at the present time and of twenty-five years ago:

	1870.	1895.
Stamp mill charges per cord	$35.00	$16.00
Labor per day	4.00	2.50
Lumber per M feet	60.00	18.00
Teaming per day	16.00	4.00
Candles per box	20.00	4 75
Giant powder per lb	1.00	.14
Fuse per M feet	30.00	6.00
Nails per keg	20.00	3.00
Iron per lb	.25	.03
Steel per lb	.40	.09
Wood per cord	8.00	5.50
Coal oil per gallon	3.00	.20
Shovels each	2.75	1.00
Picks each	3.75	1.00
Rope per lb	.60	.15
Smelting per ton	65.00	10.00

"On an average, $27 will buy as much mining supplies as $100 would buy in 1870. And yet the one ounce of gold is worth in coin just $20.67, which was its coin value in 1870. Does any one want any further reason why there has been such an increase in gold production than can be found in these figures?"

The cheapening of supplies he states to be due to "closing the mints to silver," thus throwing the labor and supply market into gold mining. A great part also is attributed to improved furnace practice and the economies derived from handling large quantities of ore. The prosperity of our gold-mining interests is local, and the "eastern farmer, southern planter, and

debtor anywhere have little or no share. It is one which affects only the gold miner and the industry of gold mining, which to-day is the most prosperous and profitable business on earth."

Florida Pebble-Phosphate Mining.

THERE are two distinctive methods of mining land-pebble, which for convenience may be termed "dredging" and "hydraulic." The first naturally applies to such mines as raise the rock from under water, and the last to such as work in dry pits. It is scarcely necessary to add that dredging is sometimes a matter of necessity and not of choice. Some car-mining has also been done in pits that could be drained, but such work has been found unprofitable, and has been wholly abandoned. In dredge-mining, all types of machines have been used. We need not here discuss the relative merits of the "dipper," the "clam-shell," and the "elevator," as their adaptability is largely governed by location and environment. Whichever one is used, the function is simply that of raising the stuff from under water and passing it to the wash-boat alongside the dredge.

All washing is done by some attrition-process, the log-washer in some form being in almost universal use. The amount of manipulation required for clean washing varies considerably in different deposits, or even in different parts of the same deposit. The *débris* is carried directly overboard, unless the necessity for preserving navigable water forces a partial departure from this practice. The washed material is taken to the mill for drying and storing. Hydraulic mining presents some points of advantage which will probably always hold it in favor wherever it is practicable, that is, wherever the pit can be pumped dry with a reasonable amount of pump-capacity. The term fairly describes the process, which is simply to play giant-nozzle streams, supplied by strong hydraulic pumps, against the wall of the pit. This rapidly disintegrates the mass and carries the loose material to the sump hole, where it is taken up by a centrifugal pump and carried to the washer.

The advantages are: (1) the washing is largely done in the pit, and only a small washer is needed on the barge or at the mill; also, the amount of washing in the pit can be regulated to meet the work of the washer, thus making it easy to handle material of varying tractability always to the best advantage; (2) the work being always in sight, the deposit can be worked clean without taking up worthless material; (3) it is probably the cheapest method of raising the rock; (4) it is less destructive of soft pebble.

It may be remarked *en passant* that soft pebble indurates rapidly by exposure and heat, so that whatever gets through the washer is not lost in any subsequent screening. The best processes now in use for mining and preparing the rock leave little room for future economies, as the plants now in operation are free from many former errors of construction and adjustment of machinery.—Trans. Am. Inst, Mining Eng.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy

2497. Shall Pig Iron be Sold in Analysis? (An editorial discussion concluding that the only satisfactory way to sell pig iron is on its per cent. composition). Eng & Min Jour–Nov. 9. 1300 w.

*2523. A New Cementation Process (A new method with similar purpose to that of the Harvey system; consists in cooling the steel before the carbon can penetrate into the molten mass too far while pouring. A section of the mold is given). Col Guard–Nov. 1. 600 w.

*2526. The Prospects of Steel Making in India. M. (Investigations into the relative cost of producing iron in India and Durham, England, and Connelsville, U. S., with the conclusion that there is a reasonable prospect for profit in pig iron made in India). Eng, Lond–Nov. 1. 2500 w.

2538. The Use of Blast Furnace Slag. Translated from *L'Industrie* (The use of acid

We supply copies of these articles. See introductory.

slag by charging it, instead of ore, in blowing out a furnace. Also the advantage of using slag in place of a poor ore to increase the slag made to the required percentage. In actual practice both these methods were found to be economical). Am Mfr & Ir Wld-Nov. 8. 1200 w.

2554 —$1.50. The Physical Qualities of Acid Open-Hearth Nickel Steel, as Compared with Carbon Steel of Similar Tensile Strength. H. H. Campbell (Read before Am. Soc. of Civ. Eng. A valuable paper giving the results of tests on nickel steel, "hard forging" steel and forging steel in order to determine their comparative qualities when manufactured into various shapes. The superiority of nickel steel is clearly shown). Trans Am Soc of Civ Eng-Oct. 1000 w.

2590. The History of Mond's Nickel Extraction Process. Ludwig Mond (Abstract of a paper read before the New York Section of the Society of Chemical Industry, giving the results of experiments which led to the present process of absorbing the nickel by C O gas). Eng & Min Jour-Nov. 16. 1500 w.

*2598. Concentration of Gold Ores. T. K. Rose (Review of a book by Henry Rosales). Nature-Nov. 7. 1600 w.

*2625. On the Treatment of Zinc Ores and Complex Ores Containing Zinc. Peter Hart (From the *Journal of the Society of Chemical Industry*. The process for removing zinc from ores by treating with sulphuric acid and dissolving the soluble sulphates, and driving off the acid by heat leaving the oxide of zinc behind). Aust Min Stand-Oct. 19. 2000 w.

2637. The Manufacture of Tin Plates. Ill. (Some observations on the industry with description of an American mill which will be continued in the next issue, also with the description of an English tin plate mill). Met Work-Nov. 16. Serial. 1st part. 1600 w.

*2641. Pig Iron from Inferior or Dirty Ores. Walter J. May (Suggesting the use of a sodium-iron alloy in furnace practice to remove oxygen and injurious impurities from the iron). Col Guard-Nov. 8. 1100 w.

*2664 The Spectrum of the Bessemer Flame and the Hardening of Steel. John Parry (A correspondent's discussion of Prof. Hartley's paper on "Thermo-Chemistry of the Bessemer Process." He gives some results of his own researches on the effect of temperature on the spectrum of iron, says that iron is not a simple element, and discusses Mr. Howe's paper on "The Hardening of Steel"). Engng-Nov. 8. 1300 w.

2666. The Production of Iron Ores in the United States in 1894. John Birkinbine (From the mineral resources of the United States. The production of iron ores classified by years, by states, by most prominent mines, and by countries, is given in tabular form. It is an official report to the U. S. Geol. Survey). Ir Age-Nov. 21. 2800 w.

2668. A Contest in the German Iron Trade (On account of the exhaustion of cheap high phosphorus iron ore, the Rhenish Westphalian district, which makes basic steel, desired a reduction of freight on government railways. This was opposed by a competing district and extensive investigations followed. It shows, as in this country, the tendency to move furnaces near the ore rather than near the coal supply). Ir Age-Nov. 21. 1100 w.

*2674. The Nature of Alloys (Abstract of the second and third of a series of lectures on alloys, showing how alloys will separate from the molten mixture at certain temperatures, having a different composition from the eutectic alloy. This separated alloy is not always the best for mechanical purposes. The mass should be cooled quickly in order that no segregation may take place). Ir & St Tr Jour-Nov. 2. 900 w.

*2681. The Iron Industry of the Saar and the Moselle. M. Jung (A paper communicated to the German Association of Engineers on the minette ores of Germany and their smelting, with economic considerations). Ir & Coal Tr Rev-Nov. 8. Serial. 1st part. 1600 w.

*2682. The Recovery of By-products in the Iron Industry (The utilization of the ammonia in furnace gases, the tar and ammonia from coke ovens, high phosphorus slags, &c., in Great Britain. In Scotland their value is said to be 3s. per ton of pig iron made). Ir & Coal Tr Rev-Nov. 8. 1200 w.

2705. Erhardt Process for Tubular Bodies (From the report of the U. S. Consul General at Frankfort. A method of forming tubes by forcing a mandrel into the hot metal contained in a matrix which is the shape desired in the finished piece. It is said to be an excellent process). Ir Tr Rev-Nov. 21. 1100 w.

2706. Contributions to the Chemistry of the Cyanide Process. E. A. Schneider (An article upon the economical use of potassium cyanide in the cyanide process and the causes for excessive consumption). Eng & Min Jour-Nov. 23. Serial. 1st part. 1300 w.

2707. Plant for the Separation and Disposal of Slag. Ill. L. S. Austin (This plant is in use at the Omaha & Grant Smelting & Refining works. Allowing sufficient time for the matte to settle from the slag is the principal feature). Eng & Min Jour-Nov. 23. 750 w.

†2712. Burnt Steel.—An Application of Theory. B. F. Spaulding (Showing the effect of oxidation and giving means for its prevention). Ind & East Eng-Oct. 19. 1600 w.

†2713. The Basic Bessemer Process (Extracts from a German circular on the importance of basic steel. Germany has contributed about half the world's production). Ind & East Eng-Oct. 19. 800 w.

2786. Analytical Methods at Duquesne. Ill. J. M. Camp (The determination of manganese by color test, of sulphur by the aqua regia or iodine method, and carbon by the method of combustion). Ir Age-Nov. 28. 1600 w.

2809. Stretching Cast Iron and Elements Involved in Its Contraction. Thomas D. West (Read at the meeting of the Western Foundrymen's Assn., at Chicago. A paper on the rel

tions between contraction and conditions of molding, mixing and cooling the castings, with illustrative examples). Ir Tr Rev–Nov. 28. 4400 w.

2810. Properties of Cast Iron Shown by Keep's Cooling Curves. W. J. Keep (The effect of silicon on shrinkage and results of some recent tests). Ir Tr Rev–Nov. 28. 2300 w.

*2821. The Capabilities of Our Blast-Furnace Plant (Though the number of furnaces has decreased in England, the productive capacity has increased ; but this capacity is much greater than the actual production). Ir & Coal Tr Rev–Nov. 22. 1100 w.

*2825. Chrome Ore as a Furnace Lining (Stating that very good results were obtained by lining the furnace with two parts of powdered chrome ore to one of lime. The chrome ore should contain 36 to 40 % of chrome sesquioxide). Ir & St R Jour–Nov. 16. 400 w.

2827. The Rarer Metals and Their Alloys. W. Chandler-Roberts-Austen (A lecture before the members of the Royal Institution covering the entire field, including alloys with iron and steel). Can Min Rev–Nov. 9500 w.

2828. The Semet-Solway Coke Oven (An illustrated description). Eng & Min Jour–Nov. 30. 1000 w.

*2847. On the So-called "Selective Action." James Mactear (A paper read before a meeting of the Inst. of Mining and Metallurgy tending to prove that there is no "selective action," but rather that a greater proportion of base metal is dissolved by cyanide). Min Jour–Nov 23. 4400 w.

†2865. Assay of Auriferous Ores and Gravels by Amalgamation and the Blow-Pipe. R. W. Leonard (The method consists in amalgamating with mercury, then cupelling with lead and measuring the bead with Plattner's scale. Results are compared with parallel tests with the stamp mill and fire assay). Trans Am Inst of Min Eng–Nov. 1200 w.

†2879. Carbides of Iron. F. Lynwood Garrison (History of the efforts to explain the phenomena connected with the affinity of carbon for iron). Jour Fr Inst–Dec. 2500 w.

2938. The Cyanide Process of Gold Extraction. John C. Montgomerie (A letter to the editor giving reasons why the MacArthur-Forrest patents are not valid). Min & Sci Pr–Nov. 30. 2000 w.

2945. The Relation between Temperature and the Grain of Steel. A. Sauveur and H. M. Howe (A diagram showing the relation of the area of the grain of steel of 1.10% carbon to the temperature from which it had cooled. The formula deduced is $T^{max}=680+281.250\ a$ where T^{max} is in degrees centigrade and a= area in sq millimeters of grain). Eng & Min Jour–Dec. 7. 400 w.

*2995. Brown's Horseshoe Roasting Furnace. Ill. (A hearth furnace of the O'Hara type, having continuous stirrers, which stir the roasting ore and convey it to leaching tanks. The plant is erected in Montana). Engng–Nov. 29. 1300 w.

Mining.

*2469. Cripple Creek Gold Mines and the Stock Boom. T. A. Rickard (Describing the geological formation of the Cripple Creek region and the character of the ore, and deploring the reckless speculation to which its richness has given rise). Eng Mag–Jan. 3500 w.

2498. The Oruro Silver Mines in Bolivia. Jorge Basadre (Description of the method of ore treatment. The mine ore is divided into the 130-oz. per ton grade, which is shipped to Europe, and the 60-oz. grade, which is treated at their mill by the chlorination process, at a cost of $14.31 per ton). Eng & Min Jour–Nov. 9. 1000 w.

2499. The Bowie Coal Mine, Texas. Ill. (The article says two Texas coal mines are now in operation, one working on a vein 22 to 26 in., and delivering about 300 tons per day, and the other where about 1800 tons a day are mined. Coal lies 401 ft. below the surface, contains 47% carbon, and costs from 70 to 80 cts. per ton to mine). Eng & Min Jour–Nov. 9. 1000 w.

*2500. Leadville, Colorado (Some details relative to the situation and organization of various mining enterprises showing the companies to be rather conservative and not anxious to invite outside capital). Min Jour–Nov. 2. 3000 w.

*2501. The Gold Mines of the Remedios District, Republic of Colombia. Frank Owen (A full account of the location, production, ore treatment, etc., of the various gold mines in this district. The mines were producing in 1613, and had produced 50 million pounds sterling of gold up to 1886). Min Jour–Nov. 2. Serial. 1st part. 3800 w.

*2502. Indian Manganese (Description of ore with analysis of manganese ore from Gosalpur, Jabalpur District, containing 54.66% of manganese). Chem Tr Jour–Nov. 2. 300 w.

*2519. South African Coal (The Transvaal coal occurs in the Karoo formation at depths from the surface to 100 ft. ; the largest has 40 ft. of workable coal, the others up to 22 ft. in thickness. The coal contains about 15% of ash, which also contains as much as 9 dwt. of gold per ton of coal. The production of the three principal mines has been 501,422 tons in 1894, employing 124 whites and 2005 natives. Its evaporative efficiency varies from 43 to 81% o. that of British coal). Col Guard–Nov. 1. 800w

*2520. Belgian Coal Industry in 1894. M. Emile Harzé (Abstract from the "Statistique de Mines, Minières Carrières, Mines Métallurgiques et Appareils à Vapeur, pour l'Annee 1894." The article gives the production as 20,534,501 tons from the 262 collieries, produced by 117,103 workers, receiving £4,406,792 in wages, making after proper deductions 2s 7d. per man per day. Also a vast amount of detail statistics given). Col Guard–Nov. 1. 2300 w.

*2522. Hard-Coal Species. Theodor Hundhausen, *Prometheus* (On the classification of coals, giving typical analyses and stating all the difficulties involved in subclassifying any variety). Col Guard–Nov. 1. 2300 w.

*2542. Dry Concentration of Gold Ores (Referring to the various methods adopted in dry

treatment and describing its application to a North Wales mine). Aust Min Stand–Sept. 28. 1300 w.

*2623. The Greatest Gold Mine in the World. Edgar Hall (A history of the Mount Morgan (Aust.) Gold Mine with abstracts from descriptions by various government geologists, T. A. Rickard, and London *Engineering*). Aust Min Stand–Oct. 5. Serial. 1st part. 2700 w.

*2624. Dry Placer Machines (Description of the method of working dry placers in the arid regions of Arizona. Panning is used on a small scale similar to the wet method. The machine used consists of a series of screens arranged so that a blast of air from the fan blows sand and dirt away; it resembles the fanning machine used to clean grain). Aust Min Stand–Oct. 5. 1000 w.

*2626. Coal Mining in New Zealand (From the annual statement of the Minister of Mines giving the output of the mines, earnings of the miners, etc. The production was 719,546 tons, employing 1899 men at an average pay per week of £2. 3s. 9d). Aust Min Stand–Oct. 19. 1000 w.

*2627. The African Diamond Mines (An account of some of the early diamond discoveries in South Africa. A Boer, named Van Nickerk, produced the first large stone which he obtained from a witch doctor for £400 in "trade," sold it to Colony Jews for £11,200, and it is now reposing in the casket of a Countess, a 46½ caret gem, worth £25,000. Other similar instances are given). Aust Min Stand–Oct. 19. 2500 w.

2639 History of the Anaconda Mine. Marcus Daly (Personal reminiscences of one of the owners). Min Ind & Rev–Nov. 14. 1400 w.

*2640. The Coal Fields and Mine Administration of Germany. E. Gruner (From the general technical description accompanying the Atlas of the Comité des Houillères de France. A brief account of the German coal and lignite deposits with the official organization in mine administration). Col Guard–Nov. 8. 2200 w.

*2642. Composition of the Air in the Mines of the Doultz Basin. N. Kotsowsky (Translated from *La Revue Universelle des Mines, de la Metallurgie, &c.* Analyses from various parts of these Russians mines are given showing that the gas exists in dangerous quantities and that ventilation is defective). Col Guard–Nov. 8 3200 w.

*2659. Quarrying. C. Le Neve Foster (A lecture at the Sanitary Institute, London, by one of Her Majesty's Inspectors of Mines. An interesting summary of methods in use in England). Stone–Nov. Serial. 1st part. 2100 w.

2675. Roumanian Petroleum (Comparison of the analyses of oils from the nine principal oil fields of the world, showing the Roumanian oil to be very rich). Am Mfr & Ir Wld–Nov. 15. 250 w.

*2680. British Labor and the Iron and Coal Industries (Abstracts from the annual report of the British Board of Trade, giving tables of interest on trades unions, boards of arbitration, wages, &c). Ir & Coal Tr Rev–Nov. 8. 1000 w.

2690. The Granite Quarries of Stone Mountain, Georgia. Ill. (The mountain is a solid mass of granite rising to 700 feet above the level of the plain. Quarrying is done by blasting and breaking to size by the plug and feather method). Eng News–Nov. 21. 600 w.

2696. Notes on Gold Milling in California. E. B. Preston (From Bulletin No. 6, California State Mining Bureau. The author gives the development of present practice in detail. A valuable contribution). Min & Sci Pr–Nov. 16. Serial. 1st part. 1800 w.

2697. The South's Coal. H. S. Fleming (The growth of coal mining as illustrated at the Atlanta Exposition. The article contains descriptions of coal from various localities and gives the analyses, and production, and other statistics). Mfrs Rec–Nov. 22. 4500 w.

*2747. The Rand Conglomerates. Mr. Kuntz (A paper read at a meeting of the Geological Society of South Africa. It gives the various theories as to the origin of the formation and the contained gold deposits). Min Jour–Nov 16. 4000 w.

*2767. The Ruhr Coalfield. M. E Gruner (A report of the Comité Centrale des Houillères de France on the nature of the coals, importance of the deposits, political division of the field and the production). Col Guard–Nov. 15. 1800 w.

*2768. New Shaft Installation at the Preussen I. Pit, near Dortmund (Description of the improved machines used for the purpose of working with the utmost possible economy). Col Guard–Nov. 15. 1100 w.

*2795. Phosphate Dressing Plant (A dressing plant composed of screens, jigs, tables, etc., designed to enrich a poor phosphate rock 20 to 30 %. A full page plate shows the arrangement of the plant). Engng–Nov. 22. 1000 w.

*2824. The Lode Structure of the Zeehan Silver-Lead Fields, Tasmania. E. Moriarty Weston (A geological and mineralogical description of the rich argentiferous galena deposits on the west coast of Tasmania). Aust Min Stand–Oct. 26. Serial. 1st part. 2200 w.

2829. Some Georgia Marble Quarries. Ill. (This gray marble is quarried entirely by channeling machines, gadders, etc., and no explosive is used. The deposit is at least 200 ft. thick). Eng & Min Jour–Nov. 30. 900 w.

2843. The Monazite Deposits of North and South Carolina. Ill. H. B. C. Nitze (An interesting article by the Asst. State Geologist of N. Carolina, on this interesting thorium producing mineral. This is one of the localities from which the world draws its supply). Pro Age–Dec. 2. 1500 w.

*2844. Some Effects Produced by the Sudden Compression of the Ventilating Air Current in Mines. James Ashworth (Illustrated account of a mine accident caused by a creep of the strata, which suddenly filled the passages, expelling the air with sufficient force to kill some miners). Col Guard–Nov. 22. 5400 w.

*2846. Methods of Mine Timbering. Ill. (Extract from Bulletin No. 2 of the California State Mining Bureau. Examples of square setts are given, including those used on the "Com-

stock Lode"). Min Jour-Nov. 23. Serial. 1st part. 2800 w.

*2848. A Year's Mining in Western Australia (Some facts and figures from the Report of the Department of Mines of Western Australia giving the production, revenue, and area covered). Min Jour-Nov. 23. 1200 w.

†2854. The Present Condition of Gold-Mining in the Southern Appalachian States. H. B. C. Nitze and H. A. J. Wilkens (A monograph, well illustrated, and conveying the latest information regarding these interesting deposits). Trans Am Inst of Min Eng-Nov. 40000 w.

†2855. Notes on the Magnetization and Concentration of Iron-Ore. William B. Phillips (Results obtained, with detailed description). Trans Am Inst of Min Eng-Nov. 10500 w.

†2856. The Magnetic Separation of Iron-Ore. Clinton M. Ball (Derivation of formulæ for calculating richness of magnetites; description of the Ball-Norton Magnetic Separator, with some results of its working). Trans Am Inst of Min Eng-Nov. 6000 w.

†2857. The Gold-Regions of Georgia and Alabama. William M. Brewer (Descriptive paper taking up the localities in detail and showing the state of development). Trans Am Inst of Min Eng. Nov. 7200 w.

†2858. Southern Magnetites and Magnetic Separation. Harvey S. Chase (Some results of experiments—the Cranberry Mines, N. C. Also representative analyses of N. C. and Tenn. iron ores). Trans Am Inst of Min Eng-Nov. 2000 w.

†2861. The Tin-Deposits of Durango. C. W. Kempton (Communication in discussion of the paper of W. R. Ingalls, showing that the deposits are not sufficiently extensive for mining). Trans Am Inst of Min Eng-Nov. 150 w.

†2862. Notes on a Southern Coal Washing Plant. William B. Phillips (Discussion of the paper of J. J. Ormsbee. Showing the relation between specific gravity and composition of some Birmingham coal). Trans Am Inst of Min Eng-Nov. 1000 w.

†2863. Notes on Certain Water-Worn Vein Specimens. F. C. Holman (The occurrence of water worn pebbles, etc., in a quartz vein 265 ft. beneath the surface). Trans Am Inst of Min Eng-Nov. 2000 w.

†2864. The Florida Pebble-Phosphates. E. W. Codington (Description of method of mining and preparing for market). Trans Am Inst of Min Eng-Nov. 3300 w.

2937. Handling Refractory Placer Ground. Ill. (A gold dredging plant at Bannack, Mont. The bucket dredge uncovers the river bottom and then makes a dam further up stream; the water is pumped from the pit below and the rich gold gravel excavated to rock by hand). Min & Sci Pr-Nov. 30. 1400 w.

2944. Quarter of a Century of Fluctuations in Mining Stocks (A table giving the name of mine, state, par value, and highest and lowest prices of stock for each year since 1871). Eng & Min Jour-Dec. 7. 600 w.

2946. Millions in Gold Beneath the Lava Flows. Dan de Quille (A section of country in Idaho, 400 miles in length, by 40 to 60 miles in width, covered by lava, under which bore holes have discovered gold bearing strata). Eng & Min Jour-Dec. 7. 1800 w.

2947. The Gold Regions of Alabama. William M. Brewer (Showing that the gold deposits worked are not beyond the prospecting stage. The ore is quartzoze and comparatively free milling). Eng & Min Jour-Dec. 7. 1000 w.

2948. The Douglas Creek Placers, Albany County, Wyoming. E. P. Snow (Description with map and half-tone illustrations). Eng & Min Jour-Dec. 7. 2000 w.

2950. The Iron Resources of Minnesota. Horace B. Winchell (Read before the Northwestern Immigration Convention. Valuable statistics are given and the economic phase of the industry is fully discussed). Ir Tr Rev-Dec. 5. 3500 w.

*2982. Installation of a Guibal Ventilator at a French Colliery. E. Gosseries (Description of the ventilator and the conditions it has to satisfy. The reasons for choosing this type and the tabulated results of experiments are given). Col Guard-Nov. 29. 2000 w.

*2984. Development of the Manganese Ore Trade in the Caucasus (Showing that the miners are selling ore at a loss to themselves). Ir & Coal Tr Rev-Nov. 29. 800 w.

*2986. Colliery Explosions Produced by Coal-Dust. Donald M. D. Stuart (The author advances the theory of intermittent subsidiary explosions). Ir & Coal Tr Rev-Nov. 29. 1600 w.

*2997. The Zeehan and Dundas Silver Field Tasmania. W. F A. Thomas (A paper read before the Inst. of Min. & Met. The geology and methods of mining are fully described). Min Jour-Nov. 30. Serial. 1st part. 4500 w

Miscellany.

*2467. The Future of the American Iron Trade. James M. Swank (Reviewing the rise of American iron and steel industries, showing by statistics their growth, and pointing out the factors likely to contribute to their increase). Eng Mag-Jan. 5500 w.

†2518. Notes on Mining Engineering and Economic Resources of Illinois (A valuable series of experiments on the economic value of Illinois coals, as shown by calorimeter tests and analyses and comparing actual value with selling price of various coals). 10th An Rept of Ill Soc of Eng & Surv. 450 w.

†2561. The Latest Eruptives of the Lake Superior Region. N. H. Winchell (The correlation between intrusive traps and sandstones in the Animikie and Keweenawan formations). Am Geol-Nov. 2000 w.

†2562. The Upper Silurian in Northeastern Iowa. A. G. Wilson (After a brief reference to the published information, the author describes the various formations and shows that there

were alterations in sedimentation between limestone and chert and that the Pentamerus beds have a fauna similar to the limestone overlying the Coralline beds). Am Geol–Nov. 2700 w.

†2563. High Level Gravel and Loam Deposits of Kentucky Rivers. Arthur M. Miller (Accounting deposits on the sides of the anticlinal by the presence of a glacial dam). Am Geol–Nov. 1800 w.

†2564. Origin of the Iowa Lead and Zinc Deposits. A. G. Leonard (A review of the various ascension, lateral secretion and descension theories of Messrs. Whitney, Chamberlin, Winslow, Blake, Kemp and Jenner, and concluding that the ore deposited was contemporaneous with the enclosing limestone and came from above). Am Geol–Nov. 2700 w.

†2565. The Devonian Series in Southwestern Missouri. Oscar H. Hershey (The lithologic and stratigraphic relations which place the formation under discussion in the Devonian. The paleontologic relations are not yet established). Am Geol–Nov. 1900 w.

2570. The North Carolina Mineral Exhibit. H. S. Fleming (Data concerning this collection which gives not only an excellent idea of the exhibit, but also of the parts of the state in which the minerals are found). Mfrs Rec–Nov. 15. 3000 w.

*2655. The Onyx Marbles. George P. Merrill (Their origin, composition, and uses, both ancient and modern. An interesting article giving the distinctive qualities possessed by each variety of onyx). Stone–Nov. Serial. 1st part. 3500 w.

*2657. The Sandstone Industry in 1894 (Giving the composition of various sandstones, and the United States production by states). Stone–Nov. 800 w.

*2658. Essential Properties of Building Stones. H. Foster Bain (From Monthly Review Iowa Weather and Crop Service. A general article). Stone–Nov. Serial. 1st part. 2200 w.

2756. Gold Production and Its Cause (An editorial stating that the increased interest in gold mining and in gold production is due to the fall in prices of supplies. Twenty-seven dollars will buy as much now as one hundred dollars would in 1870, though the selling price of gold has remained constant). Min Ind & Rev–Nov. 21. 600 w.

*2763 The Shale Oil Industry (The article describes the oil shale, methods of extracting the oil and its accompanying products. It employs two and one-half million pounds capital). Eng, Lond–Nov. 15. 2400 w.

*2776. Development of the Manganese Ore Trade in the Caucasus (Great increase over 1893, but reduction in prices and causes. Transportation difficulties, &c). Bd of Tr Jour–Nov. 800 w.

2811. A South African on South African Mines (A letter from Johannesburg giving reasons why Americans should invest in "Kaffir" securities, and showing that the remarkable recent developments are based on a genuine basis). Bradstreet's–Nov. 30. 2000 w.

2818. An Electric Mining Plant (Short, illustrated description of an 80 h. p. electric mine locomotive, which can haul daily 1200 tons of coal a distance of 3500 feet; a five foot capacity coal cutter, and a gearless electric mine drill. These are used in Pennsylvania, near Pittsburg). Min & Sci Pr–Nov. 23. 400 w.

2826. Canada and the Gold Boom (An editorial giving examples of booms and promoters with reference to the past "Kaffir" boom and the possible Colorado and British Columbia speculations). Can Min Rev–Nov. 4500 w.

†2831. Central Michigan and the Post-Glacial Submergence. E. H. Mudge (The author fails to find sufficient reason for existing theories). Am Jour of Sci–Dec. 1400 w.

†2834. Stratigraphy of the Kansas Coal Measures. Erasmus Haworth (The article gives the succession of rocks and the fossils contained in each). Am Jour of Sci–Dec. 6500 w.

†2859. The Eastern Coal Regions of Kentucky. Graham Macfarlane (Description with a number of geological sections). Trans Am Inst of Min Eng–Nov. 3500 w.

†2860. An Improved Form of Protractor for Mapping Mine-Surveys. W. S. Ayres (Illustrated description). Trans Am Inst of Min Eng–Nov. 600 w.

†2866. Biographical Notes of Eckley B. Coxe. R. W. Raymond (The life of an active, useful man in mining profession. The list of his inventions, literary works, and of the societies to which he belonged is given in full). Trans Am Inst of Min Eng–Nov. 12800 w.

†2867. Biographical Notice of Franz Posepny. R. W. Raymond (A short history of this specialist in ore deposits). Trans Am Inst of Min Eng–Nov. 5300 w.

†2868. Chrome in the Southern Appalachian Region. William Glenn (A historical description of the finding of chrome ore in the United States, with notes on the lithologic character of its associations and its manner of occurrence). Trans Am Inst of Min Eng–Nov. 7000 w.

†2869. The Geological Structure of the Western Part of the Vermilion Range, Minnesota. Henry Lloyd Smyth, and J. Ralph Finlay (A valuable contribution on the origin and associations of the rocks in this iron ore locality). Trans Am Inst of Min Eng–Nov. 18000 w.

*2985. An Enquiry into the Present Methods of Estimating Sulphur in Iron and Steel. F. A. Matthewman (Thirty chemists having made analyses of the same sample and not agreeing, the author attempts to point out where the cause for the variation lies. The results vary from 0.016 to 0.076 per cent. for pig iron sample). Ir & Coal Tr Rev–Nov. 29. Serial. 1st part. 3000 w.

2999. An Economical Air Plant Now Being Installed at the North Star Mine, Ill. Edward A. Rix (Description of a very complete system for the transmission and use of compressed air). Jour of Elec–Nov. 1800 w.

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

Sewer Construction in Water-Bearing Soils.

UPON the difficulties arising from ground water in construction of sewers, hints derived from the experience of Mr. Andrew Gates, of Muscatine, Iowa (presented by him in a paper read before the Illinois Society of Engineers and printed in its tenth annual report), will be of service to the younger members of the profession. Mr. Gates applies the term "continuously saturated soil" to all earth lying below the ground water level. He also directs attention to the fact that all ground water has a current, and that this may be "quite rapid in veins, the velocity, of course, depending upon varying conditions. The result of this is that more trouble will be experienced from one side of the trench than from the other, and the side which will give most trouble will be the inflowing side.

"In any disposition of ground water, for the purpose of protecting our work while building, and afterwards, we should not lose sight of the purpose for which the sewer is to be used. With a combined system it may be an advantage to get this water into the sewer properly, while with a separate system too much care cannot be taken to exclude it. When large quantities of water are encountered, with a separate system, if the gradients will permit, it should be drained off, emptying on the surface or into a storm-water sewer. If this is impossible, under-drains may be allowed to discharge into manholes, and these openings closed after the sewer is completed. In a combined system the quantity of water may be so great as to require similar means of disposal; but smaller springs may be run direct into the sewer, if such construction is used as will effectively keep out sand and earth."

Under-drains should be at least six inches in diameter, that the flow may not be too often interrupted by deposition of mud in them. Sump holes and pumps should be employed to prevent silting up of under-drains whenever the grades are light. "Hollow invert blocks, such as are made by several clay works," are recommended for under-drains for brick sewers. "The same trouble is experienced with them as with pipe under-drains in regard to their silting up, but they have several advantages over the pipe in other respects. They do not require the foot of extra excavation which the pipe does, and this is more of an item than might at first be imagined; for, when at the bottom of a twenty-foot trench, with a copious supply of water coming in, the moving of a foot of earth is not only expensive, but dangerous. If there is not more water than a hand-pump will handle, and the sewer is large enough for the pump to be set inside, it is convenient to leave an opening between the invert blocks about once in a hundred feet, wide enough for the suction pipe of the pump, which is to be set in the bottom of the sewer, and the water pumped back into the sewer. After the pump has been moved ahead, three or four bricks will stop the opening. A sump hole is made by leaving out a short section of the sewer, excavating below the bottom, and letting the underdrainage discharge into this. The pump can be placed over this hole, thus keeping the pump always behind the work. As often as the drain becomes clogged, the pump should be moved ahead, and, after being started in the new hole, the section from which it was moved should be built in. This method works equally well for pipe or brick sewers, and I have found it to be the most satisfactory way of using an under-drain. The drain should have a covering of at least six inches of fine gravel between its top and the bottom of the sewer. In quicksand the trench must be closely sheeted, using lapped sheeting if necessary; and in the bottom a shield made of sheet iron, U-shaped, six or eight feet long, fifteen inches deep, and width depending upon the size of pipe,

should be driven down just in front of the pipe and in advance of the excavation, which should go below grade and be filled up with gravel. I have found ten to twelve inches of gravel in the bottom of a soft muddy trench to give a comparatively firm bed for pipe."

In soft bottoms "concrete may be substituted for the gravel, or for pipe sewers the bottom may be planked. This should be done by driving stakes in the bottom of the trench and nailing one-inch boards on top of them. The stakes should be so driven as to bring their tops in a line parallel to the grade line of the sewer. For very large brick sewers it may be necessary to put in a pile foundation; but for the smaller brick sewers a concrete foundation, or timber cradle, will usually be sufficient. If a cradle is used, it should be made of two-inch plank, and should have an inner radius equal to the outer radius of the sewer. It should be fastened together by ribs on the outside. A timber cradle should be set to grade."

The greatest care should be given to the making of pipe joints in quicksands. Gaskets of oakum well soaked in cement are recommended. Keep running water away from a brick sewer as much as possible, while constructing it. Water coming in from the sides of the trench gives the most trouble. This water may be cared for by "the use of short pieces of gas pipe built into the wall, thus allowing the water to run into the sewer and *taking the pressure from behind the wall.* Two or three handfuls of dry cement around the pipe behind the wall will prevent any water following through outside of the pipe. If the seepage from the sides of the trench is not too great, a back filling made by mixing fine gravel and dry cement will often prove all that is required. The use of the pieces of gas-pipe—they should be two inches in diameter and about three inches longer than the thickness of the wall—are of great advantage, not only in the construction of brick sewers, but in building manholes and any masonry or concrete work which has a pressure of water behind it. After the cement has thoroughly set, if it is desirable to stop the water running in, it can be done by driving a wooden plug deep into the pipe and filling the end with cement. When there are a few joints in brick work through which the water comes, they may usually be stopped by caulking rags into the joints and then working in cement.

"The second method of overcoming the difficulty caused by water coming in from the sides of the trench is to start small channels at the under-drain and build them up as the brick work progresses. If the soil is such as to require no sheeting below the invert, this may be done by setting two rows of brick on end behind and with the flat side against the wall, leaving a space of two or three inches between them. By cutting little channels in the side of the trench leading to these, or by being careful to keep the back filling well tamped and lowest at these vertical channels, the water will nearly all run to them and thus down to the under-drain." Some remarks upon pumps and their use conclude this eminently practical essay.

Electric Purification of Sewage.

SOMETHING has been said in this department relative to the so-called "Hermite" process for purification of sewage, this process having recently begun to attract much attention on account of its apparent efficiency and its cheapness. In a recent lecture at the Case School of Applied Science, and also at a meeting of the Cleveland Council of Sociology, Professor John W. Langley (reported in *Electricity*, Nov. 20) makes it very clear that the honor of this invention is due to an electrical engineer, Wolf, and that it was first carried out at Brewsters, N. Y., on the Croton water shed which supplies New York city with its water. It was tried afterward in Havre, France, and has been called the "Hermite" process throughout Europe, thus by implication crediting the invention to an experimenter who followed Wolf, though it is not at present certain whether he had been informed of Wolf's successful experiments or not. Professor Langley says that, when the drainage from the town of Brewsters (flowing into an adjacent marsh, and thence into streams in

the Croton basin) was found to be a source of contamination, " Wolf proposed to decompose sea water by electrolysis, and to turn the solution of chlorine thus obtained into the drainage from the village. The plan proved to be completely successful, as shown by a report issued by Dr. Cyrus Edson, health officer of New York, in 1892 and 1893. By an expenditure of a little over five-horse power to work a dynamo, the sewage was completely disinfected, and at an estimated cost of less than one per cent. of that of the older methods using chlorid of lime or carbolic acid.

" The next important trial of the new method was in the city of Havre, in France, where it is known as the 'Hermite' process from the name of the inventor, who, in Europe at least, is considered to be the originator of the idea. After an extended trial of the system, a commission appointed by the mayor of the city made a lengthy report, establishing the following points: first, the method is cleanly, practical, and easily carried out; second, when the disinfecting fluid is allowed to lie a sufficient time in contact with the sewage, the bacteria are completely destroyed; none of them survive; third, an amount of free chlorine—one-half a gram to the liter of sewage—accomplishes complete disinfection; fourth, the process as worked at Havre, with the price of coal and wages there prevailing, seems slightly more expensive than the older methods by chemical precipitation, but this might be remedied by further experience.

" The next important installation is in the city of Ipswich, in England, where it is now being applied to the entire sewage system of the town, and with complete technical success if we may judge from a report which appeared last summer in the London journal, *Lightning*.

" The process consists in pumping sea water, or an artificial brine made from salt, through tanks in which are placed electrodes supplied with current from dynamos. The chlorids of magnesium and sodium in the sea water are decomposed into alkali at one pole and free chlorine at the other. The latter dissolves in the water and becomes the disinfecting fluid, which is then turned into the sewers, or is delivered to tanks in which the sewage is temporarily arrested. The disinfecting fluid itself is colorless, and has only a moderate odor of chlorine, while the alkali formed in the decomposition of the salt greatly lessens the corrosive action of the chlorine on metal pipes.

" In order to give a scientific basis on which to make estimates of the cost, I have made in the electrical laboratory of the Case School of Applied Science numerous experiments, using an artificial sea water which practically represented the real article. Small decomposing tanks were made after the pattern of the large ones, and the electrical energy used was carefully measured. From these it appears that 6.37 lbs. of chlorine can be made every hour from one electrical horse power This quantity, using the Havre estimate, would purify over 14,000 gallons of sewage per day of 10 hours. A hundred horse-power would therefore disinfect 1,500,000 gallons in the same time. The cost of the process will be but little more than the cost of electricity, plus that of pumping the sea water and the small additional amount for wages. These can be approximately estimated at 25 cents for 1,400 gallons when carried out on a scale of 500 horse power. Taking the wholesale price of bleaching powder, its cost to do the same amount of disinfection would be at least twenty times as great. For inland cities the cost of salt would have to be added; but even then the expense would still be much below that of bleaching powder.

" This method is one especially adapted to hospitals and large public buildings. No special electric installation would be nccessary for buildings already wired for light and power, since a moderate amount of current could be drawn from them. The salt water could be decomposed in moderate-sized tanks placed on each floor, and allowed to run into the drain system in small quantities, either automatically or by hand regulation. Thus this cleanly and practically inoffensive fluid would fill the traps of the various sinks and basins, and

so disinfect all the material while it was yet within the building and before it reached the city sewers."

Prevention of Freezing in Pipes.

THE following is the substance of an article by Dr. Bueb of Dessau, recently published in *Fortischritte der Industrie*, a translation of which is found in the *American Manufacturer*:

Since gas began to be adopted generally for lighting purposes, it has been the aim of gas engineers to prevent the "freezing in" of gas pipes. Until recently it has been the general opinion that the water vapor always present in illuminating gas caused the "freezing in" by its separation in frostlike form; and all the previously known methods for preventing this are based upon the principle of removing the moisture out of the gas before its entrance into the conduit pipes. A method formerly employed for this purpose was that of exposure of the gas in so called "freezing out" cylinders to cold, whereby the water vapor was condensed and frozen, and dry gas was obtained. But, as in the freezing-out cylinder not only the steam contained in the gas, but also large quantities of the light-giving gases, were separated, the "frozen" gas showed such losses of lighting power that the practical employment of this method was hardly possible.

An extraordinarily simple and cheap method of drying gas by means of sulphuric acid of certain concentration was patented by the German Continental Gas Company two years ago, and proved quite satisfactory in the beginning. In the last hard winter, however, the chandeliers and conduits froze in again, although the gas entered the distributing pipes entirely free from water, and an investigation showed that the pipes were perfectly stopped up by frostlike formations, just as if undried gas had been used. The only difference was that these formations did not consist of frozen water, but of frozen, almost chemically pure, benzol.

This discovery shattered at once the former opinion that the freezing in of the pipes was caused by the water vapor contained in the gas, and the author very soon discovered a method by which not only the freezing of the vapor, but also that of the benzol, was made impossible. This method is that, in the gas works, a certain quantity of alcohol vapor is added to the gas before it is passed through the meter. If, by the action of the cold, separation of water and benzol occur, the alcohol vapor carried along also separates, and, dissolving in the separated condensations of water and benzol, forces down their freezing temperatures so much that they will not congeal even at our coldest temperatures in winter, but remain in liquid condition. They can, therefore, flow back into the main conduit, and thence into the next condensing pot. A stopping up of the gas conduit by separation of solid condensations is made impossible in this manner.

The action of the alcohol vapor added to the gas is here altogether different from that caused by injecting liquid alcohol into frozen-up pipes. Dr. Bueb's method furnishes means of preventing freezing in altogether, while, in the former use of alcohol in gas works, it was only intended to thaw up conduits that were frozen in already.

In the last hard winter it was shown by experiments that the action of the alcohol vapor added at the gas works remains effective at a distance of three miles,—that is, the alcohol vapor remains in the gas. The action of the alcohol vapor, however, is stopped as soon as the gas has passed a wet gas meter, as the liquid in the meter absorbs the vapor. In the case of large establishments a small apparatus for evaporating alcohol is sufficient.

Steam or a small gas flame is used. The alcohol flows from a tank in a fine stream into the heated evaporator, where it is instantly volatilized. The hot alcohol vapor is conducted through a little pipe into the gas main, where it is at once absorbed by the gas.

In order to obtain the desired effect, about five grains of ninety-five per cent. denaturated alcohol must be added to a cubic meter of the gas; at very low temperature, about ten to twenty degrees below zero, this amount must be increased by one or two grains. In most cases it is

sufficient to commence with evaporating alcohol about half an hour before the street lamps are lit, while the addition of alcohol in the day time would appear to be necessary in exceptional cases only.

This method was employed on a large scale last winter in the gas works at Dessau, where it gave excellent results. Its advantages must not be looked for in the saving of alcohol; on the contrary, in most cases more alcohol is consumed than in the old method, which aimed only at the removal of obstructions produced by freezing in. The great advantages of the new method are found in the saving of wages, and, above all, in the entire removal of interruptions in the distribution of gas, which occur at the most inconvenient time,—that is, in the winter.

The method will commend itself to all who are familiar with the behavior of alcohol with water as being sound in principle and very easy to put into general practice.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Gas Supply.

*2488. Units in Gas Technics (Deals with points affecting the measurement of certain quantities which are of interest in gas affairs, and calculations relating thereto. First number treats of standards of illumination). Gas Wld–Nov. 2. Serial. 1st part. 2500 w.

2528. Acetylene. W. W. Goodwin (Lecture delivered at 23d Annual Meeting of Am. Gas Lgt. Asso. Illustrated by experiments; cuts of apparatus and descriptions are given. The method of generating carbide of calcium, apparatus for decomposing the carbide, and showing its illuminating power, and the cost of its commercial production are presented. Discussion). Am Gas Lgt Jour–Nov. 11. 5000 w.

2529. Notes on the Storage of Oil at Gas Works. Frederic Egner (Paper read at meeting of Am. Gas Lgt. Asso. Various methods of storing oil are described and the description is followed by a statement of the author's practical experience in oil storage in the Metropolitan gas works, New York city. Discussion). Am Gas Lgt Jour–Nov. 11. 2800 w.

*2611. A Study of the Preston Gas Works (Contains particulars of one of the best conducted gas works in England, made so by the skill with which its engineering has been designed and carried out). Jour Gas Lgt–Nov. 5. 2700 w.

*2612. The Commercial Value of Photometry. A. C. Humphreys (Discusses photometry as applied to measuring the illuminating power of gas as an article of commerce. First part deals with scientific principles involved). Jour Gas Lgt–Nov. 5. Serial. 1st part. 3300 w.

2699. How to Prevent the Freezing of Gas Pipes. Dr. Bueb (Describes a new method employed in Dessau, for preventing the stoppage of gas pipes by the freezing of either water or benzol). Am Mfr & Ir Wld–Nov. 22. 800 w.

*2703. Gas Exhausting and Condensing. C. C. Carpenter (Paper read before the Southern District Asso. of Gas Engineers and Managers, with discussion. A consideration of and dissertation upon what are ordinarily the first two stages in dealing with coal gas after it leaves the foul main of the retort-house). Gas Wld–Nov 16. 4000 w.

*2715. The Chemical Purification of Illuminating Gas. MM. Delseux and Renard (This paper took the prize of 750 francs offered by the Société Technique, France. The subjects of gas washing and gas purification, their necessity and purpose, with practical suggestions for their effective conduct are treated). Jour Gas Lgt–Nov. 12. 2800 w.

*2787. Cleansing Spent Oxide. A. E. Broadberry (Description of experiments performed at Tottenham, Eng., and diagram illustrating apparatus used. With discussion). Gas Wld–Nov. 23. 3000 w.

*2957. The New Holder at the Middlesbrough Gas Works (Illustrated detailed description of a new rope guided gas holder). Jour Gas Lgt–Nov. 26. 800 w.

Sewerage.

†2503. The Purification of Water and Sewage by Intermittent Downward Filtration. Arthur N. Talbot (The system compared with other methods of water and sewage purification has proved its value. Discussion). 10th An Rept. of Ill Soc of Eng & Surv. 2200 w.

†2504. Sewer Construction in Water Bearing Soils. Andrew W. Gates (A practical essay on methods of procedure in cases where pressure of water in the soil gives trouble. Short discussion by members). 10th An Rept of Ill Soc of Eng & Surv. 2900 w.

†2505. The Construction of a Seven Foot Single Ring, Brick Sewer. C. M. Rickard (The cause for the construction of this unusual sewer was limited appropriation. The nature of the soil through which it was run and the method of executing the work are described). 10th An Rept of Ill Soc of Eng & Surv. 1400 w.

†2507. Effect of Size, Grade and Length of Sewers upon the Efficiency of Automatic Flush Tanks (A practical discussion of the subject, reviewing current practice with automatic flush-tanks, and seemingly proving that at distances of 2,000 ft. the flow in a sewer is very little if

We supply copies of these articles. See Introductory.

at all accelerated by the use of automatic flush-tanks). 10th An Rept of Ill Soc of Eng & Surv. 900 w.

2653. The Application of Electricity in the Sewage Problem (Abstract of a paper by John W. Langley giving the results of his experiments and investigations). Elec-Nov. 20. 1000 w.

*2661. The Adams Sewage Lift. Ill. (Detailed description of plant having 20,000 gals. daily capacity at Great Grimsby, Eng.) Engng-Nov. 8. 1500 w.

2728. The Sewerage of Taunton, Mass. (Describes place and manner of final sewage disposal, the general character of the system, its alignment, capacity, and relation to the removal of storm water, and details of construction). Eng Rec-Nov. 23. 3400 w.

†2935. Submerged Pipe Line for the Pennsylvania Sanitary Sewerage Company at Reading, Penna. William H. Dechant (Illustrated description followed by discussion). Pro Eng's Club of Phila-July-Oct. 4000 w.

Streets and Pavements.

†2511. Brick Pavement Construction. A. D. Thompson (Defective foundation, or soft paving brick, or both, are considered as the chief causes of failure. This position confirmed by history of brick paving in Peoria, Ill.) 10th An Rept of Ill Soc of Eng & Surv. 8500 w.

*2912. Brick Paving from Start to Finish. M. Nicholson (The author does not advocate brick in preference to all other material but aims to describe the best practice in brick paving, as he has learned it from experience and observation). Pav & Mun Eng-Dec. 4200 w.

Water Supply.

†2506. Preservation of All Sources of Water Supply from Sewage Disposal. Robert T. Orr (An argument in support of the proposition, that all sources of potable water supply ought to be protected from sewage discharges, and maintaining that whatever mode of purification is adopted the effluent contains elements of danger when freely discharged into sources of water supply). 10th An Rept of Ill Soc of Eng & Surv. 2400 w.

†2508. The Rockford Water Works, Rockford, Ill. C. C. Stowell (Descriptive and statistical with discussion by members). 10th An Rept of Ill Soc of Eng & Surv. 4000 w.

†2509. Western Springs Water System. Ethan Philbrick (Description of a system of water works and sewerage for a small town, of unusual completeness, being as comprehensive in scope and detail as would usually be found provided for a town of ten times the population). 10th An Rept of Ill Soc of Eng & Surv. 1400 w.

†2510. Cost of Pumping Water from Well to Reservoir. R. G. Young (Of practical interest to engineers of works where wells are the source of supply. Discussion). 10th An Rept of Ill Soc of Eng & Surv. 3500 w.

2587. The Fulda, Minn., Water Works (Illustrated detailed description). Eng Rec-Nov. 16. 1500 w.

2704. Water Supply of Portland, Ore. (A detailed illustrated description). Fire & Water-Nov. 23. Serial. 1st part. 1600 w.

2727. The Scotland, Pa., Stand-Pipe and Tower. Ill. (Full detailed description). Eng Rec-Nov. 23. 1000 w.

*2744. Water Purification (Describes the leading features of the Archbutt-Deeley process, hitherto used only for trade purposes, but about to be applied to improving hard waters for town supply. The water is purified by chemicals, and the time required for purifying any given amount of water contained in a tank is said to be usually one hour). Engng-Nov. 15. 2000 w.

2839. The Rhinelander, Wis., Water Works (Detailed illustrated description). Eng Recov.-N 30. 400 w.

2939. Submerged Cast Iron Pipe Intake for the Water Works of Erie, Pa. Walter C. Brough (The method of laying the pipes under water is described in detail). Eng News-Dec. 5. 2400 w.

*2992. Leicester Water Works (Illustrated general description of a pumping engine recently installed at Leicester, Eng). Eng. Lond-Nov. 29. 900 w.

Miscellany.

2593. Incandescent Lighting by Gas and Electricity in combination. Ill. (The burner designed by Louis Denayrouze, Engineer, of Paris. The description is full and complete, being taken from the Austria-Hungarian Patent Gazette, together with the drawings of the lamp accompanying the text of the specification). Pro Age-Nov. 15. 1300 w.

2614. Col. Varigault on American Fire Departments (A French view of our fire department systems derived from a tour of inspection by the chief of the fire department of Paris and his aids). Fire & Water-Nov. 16. 1900 w.

2692. The Colwell Furnace for Light, Inflammable Refuse, New York City. Ill. (Detailed description of the apparatus and of the system employed in collecting, sorting, and treating the refuse material). Eng News-Nov. 21. 1400 w.

2693. Combinations Among Contractors (Editorial discussion of the foundation facts in connection with contractor's combinations and of the equities between the parties in the fixing of prices for contract work). Eng News-Nov. 21. 2500 w.

*2709. Halifax Sanitary Regulations (Rules and regulations for the guidance of architects, plumbers, householders, and others using the water supply, to secure the sanitary condition of buildings). Can Arch-Nov. 2400 w.

2835. A Contribution to the Literature of Differential Photometry. W. H. Birchmore (An able article containing a table showing the differential areas in the spectra of sunlight, ethine flame, gasoline air-gas flame, and the same whitened; and a diagram of illumination curves of sunlight, ethine flame, gasoline air-gas flame, and of the latter passed through "neutral tint" to whiten it). Am Gas Lgt Jour-Dec. 2. 1800 w.

RAILROADING

English and American Railroad Cars.

OUR cousins across the Atlantic are beginning to realize the possibility of improvements in their railway service, and are consequently looking into our present practice with interest. *The Railroad Car Journal* (Nov.) abstracts from a paper read by Jeremiah Head at a meeting of the Cleveland (Eng.) Institution of Engineers, as follows: "I have already expressed an opinion that the Americans are ahead of us in railway vehicles. In the United Kingdom the average length of a passenger's journey is 7.2 miles. In the United States it is 22 miles, or three-fourths times as much. In our country, dining- and sleeping-cars are needed on very few lines and very few trains. In America, they are rather the rule than the exception. On account of the great distances, traveling must largely be done by night as well as by day, and this could not be long endured, if the cars were not made thoroughly comfortable. This is not a question of luxurious fittings, good attendance, good commissariat, and sleeping arrangements only, for these could be added to any vehicle of sufficient capacity. It is still more a question of easy springs, efficient heating and lighting, and freedom from draughts. In ordinary English rolling-stock the weight rests upon the two ends of a laminated spring, a buckle, carried by the axle-box, grasping the centre. Let us suppose the carriage, excluding wheel and axles, to weigh 12 tons, and to be carried on 6 wheels, each supporting 40 cwt. If time were allowed, the carriage would be raised ½ in. when the wheel rolls over a ½ in. obstruction, causing a blow on the carriage equivalent to 7.8 ft.-lbs. Now, instead of making passenger cars as light as possible, as our railway companies do, the Americans purposely make them heavy, even building weights (as I am informed) into the framework. The usual weight of a Pullman palace car is 30 tons, or 24 tons excluding wheels and axles, and is carried on bogies of 6 wheels each. By reason of an arrangement of levers, when the wheels pass over a ½ in. obstruction, the car body is raised but $\frac{1}{12}$-in. with a blow equivalent of 0.92 ft. lbs.

"On an English railway a passenger in any carriage, whether third- or first-class, can easily count every rail joint passed over by the nearest rail below him. On the New York Central I found it impossible to do this, because there were no jolts to count,—a result due partly to the bogie system and partly to the better mode of jointing the rails." After showing the superiority of American cars in heating, lighting, and ventilation, the paper continues: "English railway companies may fairly claim to have succeeded in conveying passenger traffic with far less dead-weight than the Americans. The average dead weight carried per passenger in the two countries in well-filled trains is approximately as follows:

	First-class.		Third class.	
	England.	America (Pullman car).	England.	America (ordinary car).
No. of seats in carriage..	30	30	50	70
Tare of carriage, tons.....	15	36	15	27
Tare per passenger, cwts..	10	24	6	7 7

"In the first and second columns of figures, I have compared English first-class carriages with the palace-, chair-, and sleeping-cars usual in the United States; and, in the third and fourth columns, English third-class carriages with ordinary American passenger-cars. I have not included separate dining- or kitchen-cars in either case.

"In freight-cars the Americans carry less dead weight than we do per ton of freight. Let us take the traffic in coal as an instance:

	England.	America.
Maximum load.....	8 tons.	30 tons.
Tare of car.....	4 "	9 "
Tare per ton of load....10 cwts.		6 cwts.

"This remarkable advantage over us is due to the use of very long cars carried on two bogies."

Number and Classes of Railway Employees.

IN the report of the interstate commerce commission for the fiscal year ended June 30, 1894, will be found valuable statistics relating to our railway systems and their management. *The Railway Age* (Oct. 25) takes from this report some statistics relating to men connected with the railways. In 1891 there was a total of 784,285 persons employed, which increased in 1892 to 821,415. "The large increase of nearly 90,000 in the 2 years from 1891 to 1893 is to be ascribed largely to the influence of the World's Fair, for which preparations commenced long in advance. The panic, however, tended largely to offset the increase of railway activity resulting from the exposition, and, when the great show closed and the general business depression was unrelieved, the railways were forced to sharp retrenchment; and so it is not very surprising that in a single year there was a decrease of nearly 94,000 employees from the extreme figures of the year before." The following table for the 2 years up to June 30, 1894, shows this decrease in detail:

Class.	1894.		1893.	
	Number.	Per 100 miles of line.	Number	Per 100 miles of line.
General officers	7,035	4	6,610	4
General office clerks	24,779	14	27,584	16
Station agents	28,199	16	28,019	17
Other station men	71,150	41	75,181	44
Enginemen	35,466	20	38,781	23
Firemen	36,327	21	40,359	24
Conductors	24,823	14	27,537	16
Other trainmen	63,417	36	72,929	43
Machinists	29,245	17	30,869	18
Carpenters	36,328	21	41,878	25
Other shopmen	84,359	48	93,709	55
Section foremen	29,660	17	29,699	18
Other trackmen	50,711	85	180,154	106
Switchmen, flagmen, and watchmen	43,219	25	46,048	27
Telegraph operators and dispatchers	22,145	13	22,619	13
Employees — account floating equipment	7,469	4	6,146	4
All other employees and laborers	85,276	48	105,166	62
Unclassified	....	.....	284	....
Total	779,608	444	873,602	515

It will be seen that "the general and other officers number but 7035 out of the grand army of nearly 780,000, or less than one officer to over 100 privates."

Improvements on Prussian Railways.

THE growing use in Europe of double-headed rail sections supported and keyed to cast-iron chairs is becoming so apparent that railroad men in this country should look into the reasons for this preference over flat-bottomed rails. In an excerpt from a paper before the Institute of Civil Engineers by Mr. R. Goering, the *Iron and Steel Trades Journal* (Oct. 19) thus remarks:

"Flat-bottomed rails on the Prussian State railways are gradually being superseded by double-headed rails with chairs. After discussing the advantages of chair permanent way over that with flat-bottomed rails, the author points out the directions in which the former requires improvement, which are as follows: (1) some means to prevent the sliding of the rails; (2) a better fastening between the rail and the chair; (3) an increase of the contact surfaces between the chair and the spike; (4) an increase of the bearing surface of the chair on the sleepers." The author submits designs covering the above proposed improvements, shown in two plates accompanying his paper. "The bearing surface of the chair on the sleeper he increases from 41 to 85 sq. in., and the weight from 17.63 lbs. to 50 7 lbs. The bearing surface of the rail has also been increased from 2.95 in. to 5.71 in., and three spike holes are provided, in place of two." The rails are fastened into the chairs by oak keys 8½ in. long by 2¼ in. extreme width, costing 0.36 d. each. Treated wooden keys were found to possess no special advantage, and cost 2½ d. each. "The spikes are 7¼ in. long, with a diameter of 0.63 in., widening to 0.79 in. for the portion in contact with the chair. On the old permanent way eight sleepers are used for a rail 24.70 ft. long; on the new nine sleepers are used, the end sleepers being 0.94 ft. from their centres to the rail end, the intermediate sleepers being 2.82 ft. apart, center to center. The outside fish plates are 32.76 in. long and weigh 33 lbs. each, while the inner ones are

19.13 in. long and weigh 20 lbs. each." On the Brunswick and Meine line cast-steel keys were used in place of wooden ones with satisfactory results, though with a slightly increased cost. "The author estimates the cost per lineal yd. of this permanent way (excluding sleepers and ballast), with rails weighing 82½ lbs. per yd., at 18s. 3d.; and of permanent way, with flat-bottomed rails at the same weight, at 14s. 8d." Including sleepers and ballast, the cost would be, per mile, £2414 for the former and £2092 for the latter. Taking into consideration the greater cost of double-headed rail equipment, it would be interesting to know the reasons in detail for their increased use.

The Docteur-Brick-Lined Fire-Box.

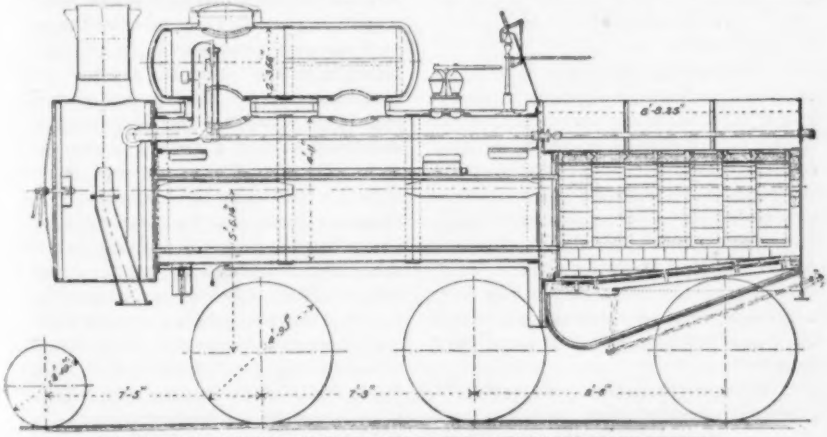
IN a digest of an article in the *Revue Industrielle*, given in *The American Engineer* (Nov. 28), there is a description of a new feature in locomotive practice. "The Belgian railway has recently resumed the use of red copper tubes and coal; and tubes of this character seem to be giving satisfactory results. Also the red copper tube sheets in the smoke-boxes appear to act very well in service, but were entirely too expensive." The sides, top, and back of the fire-box are lined with firebrick, having an air space at their back. The reduction of heating surface is compensated by increasing the number of tubes.

"The several tests which have been made with the new boiler have given very satisfactory results from the standpoint of the evaporation of water, which has risen to as much as 8½ to 9 lbs. of water per lb. of coal burned while hauling through trains with a light load.

"This locomotive has been in service since January, 1894. It was found that the combustion of the coal in the fire-box was perfect,—a result that is undoubtedly due, in the first place, to the high temperature which is maintained in the fire-box, whose walls are not continually cooled by contact with water, as is the case in the ordinary boiler; and, secondly, to the fact that the hot air admitted above the coal burning upon the grate is sufficient to burn all of the gases that are set free by the heat of this combustion.

"The admission of the air which circulates between the two casings in the arch of the double wall effects a perfect smoke consumption or smoke prevention, regardless of the quality of coal that is used; thus, the new fire-box has been stoked with the Flénu coal for welding furnaces, with pure semi-bituminous coals, with a mixture of semi-bituminous and hard coal, and, in all of these tests, it has been impossible to detect any difference in the color of the smoke. The steam capacity has been increased 25 cu. ft. by the drum shown.

"While the fuel consumption of the



LOCOMOTIVE ON THE BELGIAN STATE RAILWAY, WITH DOCTEUR'S BRICK LINED FIRE-BOX.

same locomotive, with its old boiler, fired with good coal, was always more than 77 lbs. per mile, it has dropped, with this new boiler, to 54.2 lbs. on an average over a measured run of 11,625 miles.

"Two series of tests have been made with this boiler; the first related to the consumption of fuel and water. On averaging sixteen experimental runs, it was found that 7.7 lbs. of water were evaporated per lb. of coal burned.

"In the second series, the total work done by the locomotive was measured; the consumption of coal during the interval was taken into consideration, and finally an allowance of fuel was made to the engine for the work performed. The following are the results obtained:

Distance Run in Miles.	Virtual Units Hauled	Consumption of Coal in Lbs.			Allowance of Fuel Made in lbs.
		Bituminous.	Hard.	Total.	
210 65	25,984	3,528	6,615	10,143	17,228
908 46	119 888	18,960	36,162	55,122	73,749
531.28	68,776	6,615	21,160	27,775	39,038
1650.89	214 648	29,103	63,937	93,040	130,010

"It will be seen from these figures that the consumption of coal per mile run was about 56.38 lbs., or .43 lbs. per virtual unit hauled, which shows a saving in the total consumption of 36,970 lbs., or 33 per cent.

"Steam has always been generated in this boiler, even from cold water, in an hour and a half at the outside, whereas it ordinarily requires at least three hours. The expansion of the shell has been very accurately measured by means of marks on the frame, and it has never exceeded .16 in. to .2 in.

"These considerations have led M. Docteur to conclude that this boiler is absolutely safe, and that, furthermore, it will allow of a very important saving in the invested capital, as compared with the ordinary boiler on a freight locomotive which is of essentially the same dimensions,—this saving being placed at 5,000 francs" ($965).

Replacing Trestles with Earthwork.

In describing some of the interesting features of the Canadian Pacific Railway before the Canadian Society of Civil Engineers, Mr. P. Alex. Peterson tells how various difficulties were overcome in replacing temporary with permanent roadbed. *The Engineering News* (Nov. 28) extracts some examples from his speech. The first is "Trestle No. 226 A, 1,248 miles west of Montreal, a pile trestle 335 ft. long and 8 ft. high, crossing a soft spot in a swamp. Had the bottom been firm, only 2,880 cu. yds. of filling would have been required, but soundings were taken through black muck and soft clay for 60 ft. without finding a hard bottom. When 6,912 cu. yds. had been put in, the track dropped 4 ft. on the whole line of the trestle. Filling was continued, but, when 54,600 cu. yds. in all had been put in, the filling sank faster than it could be put in," the track falling as much as 11 ft. below grade. The track was raised by sawdust filling, which has remained in perfect order. Trestle No. 169 was filled entirely with sawdust with slopes 3 to 1. The sawdust was covered with a foot of ballast, and, after settling had been followed up on a 75-ft. section for three months, the sawdust remained permanent. It may be interesting to know that the sawdust bank yields less under a passing train than the trestle, and has less spring in it than a muck bank, over a swamp of the same character. Trestle No. 177 was on piles driven into 20 to 40 ft. of soft mud. Settling was constant and serious while "filling in" was in progress, and until the new material had replaced the mud. At various points on the line settlements of 40 and 52 ft. have taken place, owing to sliding of the mud into the lake bottom. Some settlings are difficult to account for. When foundations are good, the filling of a large trestle is accompanied with little or no risk, and the considerations are principally those of cost. "The material used on the eastern and western divisions was loaded with steam shovels on flat cars, and unloaded by means of the ordinary ballast plow drawn over the length of the train by the locomotive." A pneumatic dumping device was afterward adopted, doing away with man labor. "Two large embankments, one containing 66,000 yds. and the

other 144,000 yds., have been made by sluicing gravel from adjoining hills. The first embankment was filled at a cost of $5,839, of which $2,862 was for labor and the balance was for plant and material used in boxes, etc. Charging 20 per cent. of cost of plant against this filling reduces the cost per cu. yd. to 7.15 cents. In the second filling the water was carried in a 15-in. pipe under 125-ft. head to a giant or monitor such as is used in hydraulic mining, having a 5-in. nozzle. The gravel and water is led off in a flume having a grade of 11.5 to 25 per cent. This stream will carry down on to the dump 750 cu. yds. in 10 hours.

In another article in the same number the editor gives a number of examples of the filling in of trestles. In this connection he says: "Returning to the question of comparative cost of permanent earthwork construction in the first place, and temporary trestling, followed later by permanent earthwork, it may be noted that in a report on the physical condition of the Lake Erie & Western Railroad in 1894 it is stated that the cost of standard frame or pile trestles, say, 15 ft. in height, is about $7 per foot run, and their average life is nine years. The cost of permanent structures where iron-pipe culverts or stone arches can be used, and the height does not exceed 15 ft., is said to be but little more than the cost of a trestle, and seldom exceeds twice the cost, including the cost of filling the opening with earth. For longer openings, where plate girders and masonry are necessary, the cost is little more than twice, and seldom exceeds three times, the cost of a trestle. The cost of filling with a steam shovel and an 'unloader' plow, in 1894, was about 12 to 14 cents per cu. yd., including wages of train crew and laborers, fuel, oil, waste, and repairs." An example showing the comparison in detail is here given:

First construction:	
Earthwork (at 28 cts.)	$27,042
Openings in bank	28,000
Total for permanent const.	55,042
Trestle, cost of	11,708
Saving in first cost by trestle	43,334
Gradual construction:	
Trestle	11,708
Filling trestle (at 10 cts.)	9,658
Openings in bank	28,000
Total	49 366
Saving over earthwork ($55,042)	5,676
Comp. int., 8% on $28,000, 6 yrs.	16,432
" " " " 9,658, 4 "	3.481
" " " " 5,676, 6 "	3.331
Saving by trestle replaced by bank	28,920

Taking the cost per 1,000 ft. B. M. of timber at $40, and the total cost of iron, foundation, engineering, etc., at $53.90, we have the following relation for various heights of trestle:

Height, ft.	Lumb'r B. M., per 16 lin. ft.	Cost of trestle, at $53.90 per M. B. M.	Bank, 16 ft. lgth., 10% shr'kge cu. yds.	Cost of bank, at 28 cts. per cu. yd.	Ratio of cost of trestle (1) to b'nk.
17	1,941	$104.60	415.6	$116.36	1.11
22	2,201	118.62	648.3	180.69	1 51
27	2,765	143 65	924.0	258.72	1.80
32	2,864	159.76	1,251 6	3 0.94	2 29
37	3,478	187.46	1,628.0	455.84	2.43
42	3,808	205.25	2,053.3	574 83	2.80
48	4,392	286.73	2,628 3	795 80	3.11

Economy in an Electric Road Power-House.

In a paper read before the Street Railway Association of the State of New York by Mr. H. S. Newton, and published in *The Electrical Age* (Nov. 9), an opinion was presented to the effect that all modern power-houses should be installed with an idea to maximum economy. To this end experiments have been in progress at the Syracuse Street Railway Company's plant, which derives its power from three upright double compound engines with 16½ × 31-in. cylinders and 24-in. stroke. The steam from these engines exhausts into a surface condenser, and the water of condensation is "pumped through an oil filter or separator into a hot well, from which the boiler feed-pumps convey it through a pipe-heater to the boilers. By this arrangement, not to exceed ten per cent. of the boiler feed-water is taken from the outside water supply, and all difficulty with scale is practically overcome." Five to ten degrees temperature were saved by covering the feed-water pipes with insulating material, while the life was increased and rattling of the boiler check-valve was prevented by the introduction

of another check-valve just beyond the pump, and the use of an air chamber. The use of an auxiliary injector for each boiler is recommended, as the pumps usually need frequent repairs. The character of Syracuse water made it desirable to use the condensed steam from the condensers, and ninety per cent. of the feed water is derived from this source. After a great deal of experimenting with the dark brown sediment which persisted in caking on the bottom sheets, the following causes were discovered: "(1) The use of too much cylinder oil; (2) the use of the wrong kind of cylinder oil; (3) insufficient filtration of the oil from feedwater before going to the boiler." Following these conclusions, but three drops of oil per minute were allowed per engine cylinder; purely mineral stock oil was used with the most satisfactory results; vertical partitions, causing flow over one and under the next one alternately, were introduced into the filter, which facilitated the catching of dirt and oil by the excelsior. These remedies were effective, and no trouble is now experienced from the caking of oil scum in the boilers. The cheapest fuel was found to be buckwheat anthracite coal, and mechanical devices are used for its handling and regulation in preference to trusting to hand labor. "We have found that the less responsibility you place in the man who shovels in your coal, the better off you are in the end." The vertical engines are somewhat noisy, as the cross-heads must be kept loose in the guides to prevent heating. Much importance is attached to constant and well-governed speed in the engines, as several per cent. of the loss in transmission of current may thus be saved. "In conclusion, I cannot refrain from adding one more voice to the cry against cheap labor in the power-house. Our present engineer in charge was employed by me after a very close demonstration that a cheap man was not capable of handling the plant."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Technical Journals—See Introductory.

*2468. Are American Railway Rates Too High? H. T. Newcomb (An analytical comparison of the rates of travel and transportation prevailing at different periods of this country's history, and a consideration of the causes operating to raise or lower these rates). Eng Mag–Jan. 3700 w.

2530. Improvements in Freight Car Trucks. Ill. (Designs of cast steel and rolled steel I beam truck frames, having in consideration economy of first cost, simplicity, durability, and facility for repairs). R R Car Jour–Nov. 1100 w.

2531. Church & Ettenger's Truck for 60.000 lbs. Capacity Car. Ill. (Design for a diamond frame freight car truck, by an English firm, resembling in most respects American practice. The truck and bolsters are adapted to tubular frame car construction). R R Car Jour–Nov. 900 w.

2532. Drawing Office Method. J. R. S. in "New York Railroad Men" (An outline of methods used in practice respecting indexing drawings, scales, tracings, numbering drawings, etc). R R Car Jour–Nov. 600 w.

2533. Refrigerator Car; Merchants' Despatch Transportation Company. Ill. (Description with detail drawings). R R Car Jour–Nov–1600 w.

2534. Cost of a Passenger Car (Detailed and itemized cost sheet giving the number of pieces of each article entering into construction and fitting, with labor required at a total cost of $4411.67). R R Car Jour–Nov. 2800 w.

2535. An English View of American Railroad Cars Jeremiah Head (Extract from a paper read before the Cleveland Institution of Engineers showing the superior conveniences and comfort of American cars, and though the dead weight is comparatively greater on American roads for passenger traffic, it is less with freight). R R Car Jour–Nov. 1600 w.

2540. A National Classification of Freight (Presented before the National Asso. of Agricultural Implement and Vehicle Manufacturers. Reasons *pro* and *con* relating to improvements in freight classification). Ry Rev–Nov. 9. 1500 w.

2541. Improved Automatic Trap for Indirect Car Heating. Ill. (A trap operating on the same principle as the compensating pendulum, letting in hot-water or steam only after the temperature lowers). Ry Rev–Nov. 9. 700 w.

2543. A Speed of One Hundred Miles an Hour. G. T. H. (Consideration of the requirements to attain such speed, and the points of superiority of electricity presented). Elec Ry Gaz–Nov. 9. 1000 w.

2546. A Plea for the Motorman. A. E. D. (The importance of the motorman's work, the need of appreciation, desirability of attracting a better class of men, etc., with comments on the work). Elec Eng–Nov. 13. 1700 w.

We supply copies of these articles. See introductory.

2556. No Seat, No fare, in Europe. C. L. Bonney (Report made to the Mayor and city council of Chicago. Brief account of transportation interests in London, Berlin and Paris, with remarks on joint use of tracks and municipal ownership). Elec–Nov. 13. 2200 w.

*2572. The Continuous Rail in Street Railway Practice. Ill. Richard M'Culloch (A valuable paper which was read before the Eng.'s Club of St. Louis, giving a history of methods for welding rails with a description of the two practicable methods in operation, *i. e.*, electric welding and cast welding. The author concludes that the plan has given perfect satisfaction where adopted). St Ry Rev–Nov. 15. 6300 w.

2574. Conduit Electric Railway at Madras, India. Ill. (A railway that is interesting as being the first electric in India, and also because it is constructed on the conduit system. The outer rail is of the grooved girder type, while the conductor is an insulated T rail). Eng News–Nov. 14. 300 w.

2576. Tracklaying on the Minneapolis, St. Paul & Sault Ste. Marie Ry. in 1893. Ill. (A complete detailed description. Several devices are shown in the inset illustration for facilitating rapidity of handling of ties, spikes, bolts, plates, &c. The labor and expense account are given along with other valuable details). Eng News–Nov. 14. 2800 w.

2583. Emergency Brake Problem. Walter E. Harrington (Records of tests made by the writer with conclusions drawn at the time). W Elec–Nov. 16. 1500 w.

2592. Some Notable English Engines. Herbert T. Walker (A description with illustrations of five engines of various types used on English railways. The wheels and boiler were painted bright green, the frame red, and they abounded in polished brass parts. A diagram is given showing the comparison boiler heights, from 2 ft. 8 in. above rails in an English engine, to 8 ft. 11½ in. in No. 999 of the new York Central railroad). R R Gaz–Nov. 15. 2700 w.

*2599. The Hörde Conduit System. Ill. (The aim has been to construct a conduit strong, cheap and easily accessible for repairs. Descriptive). Elec Rev, Lond–Nov. 8. 1400 w.

2615. Car Ventilation (An editorial upon the importance of fresh air in railway cars, and how to secure this without draughts, cinders and other annoyances). Am Eng & R R Jour–Nov. 14. 3800 w.

2616. Car Ventilation (Abstract of a paper by S. H. Woodbridge, of the Mass. Inst. of Technology, giving the requirements in car ventilation and stating that if pure air is introduced there will be no trouble in expelling the vitiated air). Am Eng & R R Jour–Nov. 14. 600 w.

2617. Electric Cable Railway up the Stanserhorn (A three section cable line in the Alps, having a length of 13,124 ft. and a difference in elevation of 1400 ft.; it is operated by electricity generated by water-power). Am Eng & R R Jour–Nov. 14. 1000 w.

2620. The Breakage of a Locomotive Driving Axle on the Great Northern Railway of England (Abstract of a report to the Railway Dept. of the Bd. of Trade. Description of the accident showing that there was a previous crack in the axle, inside the hub, and discussing the methods of testing for such imperfection. The axle within the hub is now made of greater diameter than the remainder, which was not the case in the English engine mentioned). Am Eng & R R Jour–Nov. 14. 2100 w.

2621. The First Steam Locomotive. From *English Mechanic* (Description, with cut, of a practical locomotive antedating George Stephenson's *Rocket* by nearly thirty years. It was designed by Richard Trevithick). Am Eng & R R Jour–Nov. 14. 1200 w.

2622. October's Heavy Railroad Earnings (The article gives the October earnings of 1894 and 1895 for each of the 125 roads in the United States and Mexico, showing a gross increase of 6·8 % over 1894. The gross October earnings amounted to $54,837,075). Bradstreet's–Nov. 16. 1000 w.

*2629. The Brighton and Rottingdean Seashore Electric Tramroad (The roadbed is under water a considerable portion of the time, and so the car is mounted on a framework 23 feet above the rails. The power proposed is electricity. The line will be used for passenger traffic). Eng, Lond–Nov. 8. 800 w.

*2630. Railway Economics (Editorial comments on a series of lectures by Mr. Acworth on "Railway Economics" before the Society of Arts. The article disagrees with the opinions of the lecturer and says that technical education is not a necessity in railroad management and operation). Eng, Lond–Nov. 8. 2200 w.

*2631. New South Wales Government Railways and Tramways. Ill. (An exhaustive article embracing maintenance of way, construction, rolling stock, traffic department, safety appliances, etc. Illustrations of locomotives and cars are given). Eng, Lond–Nov. 8. Serial. 1st part. 3300 w.

2646. A Trip on the Baltimore Electric Locomotive (Descriptive of some novel features not previously noted). Elec Ry Gaz–Nov. 16. 1200 w.

2647. E. M. Traction System. Ill. (A brief description of the method adopted by James F. McLaughlin of Philadelphia). Elec Ry Gaz–Nov. 16. 1000 w.

2648. Overhead Feeder and Trolley Construction of the New Orleans Traction Company. Map. W. Nelson Smith (A line interesting because of its size and the peculiar conditions prevailing). Elec Ry Gaz–Nov. 16. 1700 w.

*2677. A Running Shed: Its Work and Experiences. A. E. Lockyer (Illustrated from numerous photographs showing the method of cleaning engines, washing out boilers, inspection and repair of engines and wrecking trains, with description). Ry Wld–Nov. 3000 w.

*2678. Bristol Electric Tramway. Ill. (A British electric city railway of American design but with important modifications. The trolley wire supports are ornamental iron posts, carrying also the electric street lamps. There is a com-

plete description of power plant, rolling stock, permanent way and management). Ry Wld-Nov. 4800 w.

2679. Mileage of Railway in European Countries (Interesting information from the report of bureau of railways of the French government. The mileage of each European country at the end of 1894 is given with the increase over the previous year. Russia heads the list with an increase of 1212 during 1894). Ry Age-Nov. 15. 350 w.

2684. Tests of Signal Pipe Connection (These tests were made on galvanized and ungalvanized iron pipe, one inch diameter, for the purpose of determining whether galvanizing affects the strength, and also to find what the strength limits will be. Specimens were two inches and twelve inches long). Ry Rev-Nov. 16. 400 w.

2685. Mitre Rails. Jerry Sullivan (Comment on the report of committee of the Roadmasters' Association of America. Splitting of the end of the rail along the web and hammering of the head at the joint was ascribed to the rigid joint caused by too solid tamping of the adjacent ties). Ry Rev-Nov. 16. 1300 w.

*2689 A great American Railway (Report of a very entertaining interview with Col. Taylor, the London representative of the Pennsylvania Railroad, giving many items of interest not generally known). Trans-Nov. 8. 1400 w.

2716. Service Record of the Richmond Compound. W. R. Trigg (A table showing the comparative performances of simple and compound locomotives. The compound type saved 24.5 % of coal, and 7 9 % in repairs). R R Gaz-Nov. 22. 350 w.

2717. Intercepting and Reducing Valves of the Rogers Compound Locomotive (The description is detailed and illustrated by sections. They are used on a passenger locomotive built for Chile). R R Gaz-Nov. 22. 1200 w.

2718. The New Four-Cylinder Compound Locomotives of the Paris, Lyons and Mediterranean (Locomotives with new features such as an air cutting front and having cylinders in same horizontal plane. Full particulars are shown on drawings). R R Gaz-Nov. 22. 900 w.

2719. An Inspection Car for the M. K. & T. Ill. (An open car carrying six persons at a speed of 35 miles an hour). R R Gaz-Nov. 22. 400 w.

2720. Painted or Planished Iron Jackets for Locomotives. E. E. Russell Tratman (A paper before the New York Ry. Club, giving the experience and practice of a number of roads, showing that painting iron is not only cheaper in first cost, but that it has a longer life than planished iron). R R Gaz-Nov. 22. 1800 w.

2721. Solid Bridge Floors of Old Rails (Girder bridge construction on the Chesapeake and Ohio. Sections and detail drawings accompany the article). R R Gaz-Nov. 22. 600 w.

2722. Joint Traffic Association Agreement (An agreement in full, entered into by the Presidents of the Trunk Line and Central Traffic Association, on Nov. 19, to establish traffic standards). R R Gaz-Nov. 22. 2700 w.

*2740. Horseless Tramways (An excellent article abstracted from the *Pall Mall Gazette*, comparing the mileage, receipts, expenses and profits in steam, horse, cable and electric lines in Gt. Britain. In Birmingham the cable road gave far the largest profits). Prac Eng-Nov. 15. 800 w.

†2746. Light Railways (A British Consulae Report on Hungarian light, secondary railways showing that but eight out of sixty have paid dividends and the total percentage deficit has been, in 1892, 11 09%). Ind & East Eng-Oct. 26. 700 w.

2752. The Cleveland Disaster. Ill. (An account of a car plunging through the open drawbridge of the Central Viaduct, and falling 100 ft. into the river, causing the death of many persons). Elec Ry Gaz-Nov. 23. 700 w.

2754. The Pennock Steel Car. Ill. (A 30-ton capacity flat top freight car made entirely of steel. Not a particle of cast iron or wood has been used in its construction, and the weight is 2 to 4 thousand less than a similar wooden car). Ry Rev-Nov. 23. 900 w.

2755. Important Air Brake Decision (The claims, argument and opinion of the court in the infringement suit between the Westinghouse Air Brake Co. and the Boyden Air Brake Co. Considerable information is embraced in the arguments on destruction). Ry Rev-Nov. 23. 8000 w.

2757. Building Temporary Trestles. Ill. (A paper read before the Assn. of R. R. Supts. of Bridges and Buildings on methods of handling wrecks, replacing trestles, bridging wash outs, and expedients for similar emergencies). Ry Age-Nov. 22. 3800 w.

*2761. The Continuous Rail in Street Railway Practice. Richard McCulloch (Description of method and apparatus in both electric and cast welding, with the results of experiments, calculation of strains and comparison of methods. Examples of both these methods, are in actual operation, furnishing a good ground line electric conductor, and costing little more than fishplate joints). Jour Asso of Engng Soc-Oct. 6000 w.

*2765. High Speeds in the United States (Editorial comment on the Lake Shore train speed record. The writer is doubtful as to the possibility of such fast time and asks how it was done). Eng, Lond-Nov. 15. 1500 w.

2788. Air Brakes on Freight Trains. A. M. Waitt (Abstract of a paper read at the Nov. meeting of the West. Ry. Club on the details of operation of air brakes. With editorial). R R Gaz-Nov. 29. 4600 w.

2791. The October Discussion of Block-Signal Rules (Some editorial criticism of the work of the committee of the Amer. Ry. Assn. on block-signal rules, with numerous notes and some references). R R Gaz-Nov. 29. 1900 w.

*2792. The Reconstruction of the Canadian Pacific Railway (Brief history of the enterprise and illustrated description of difficult and interesting details of the work). Engng-Nov. 22. Serial. 1st part. 2500 w.

*2794. American Express Locomotives (Tabulated statement of dimensions and perfor-

mance of locomotives 599 and 564 in the recent races from New York to Buffalo, and Buffalo to Chicago). Engng–Nov. 22. 1700 w.

2802. The Canadian Pacific Railway, as Seen by an Engineer. Thomas C. Clarke (A description of the organization, capitalization, operation, and points of engineering interest of the road Twenty thousand men are employed and there is always a surplus in the treasury). Eng News–Nov. 28. 2500 w.

2803. Replacing Trestles with Earthwork (Editorial. A detailed comparison as to cost, expediency, etc., of various forms of railway trestles with embankments. Some valuable data is given). Eng News–Nov. 28. 3000 w.

2804. Replacing Trestles with Earthwork; Canadian Pacific Ry. P. Alex. Peterson (Filling in of Trestles and similar replacement work. The subject of a paper before the Canadian Soc. of Civ. Engs.) Eng News–Nov. 28. 3000 w.

2805. Standard Highway Bridge of Steel Rails; Baltimore and Ohio R. R. (The cost of these bridges is less than for wooden structures. They are otherwise perfectly satisfactory. Drawings of side and end elevation are given). Eng News–Nov. 28. 300 w.

2870. An Important Car Coupler Decision (A case in the U. S. circuit court, Gould Coupler Co. vs. Pascal P. Pratt et al. The Browning, Hein, Prior, Barnes, etc., patents are discussed in the article. Also editorial comment). Ry Rev–Nov. 30. 5200 w.

2871. Interlocking Work on the Metropolitan Elevated of Chicago (An illustrated description showing arrangement of switches, signalling apparatus, and lift drawbridge device). Ry Rev–Nov. 30. 1500 w.

2872. Electric Railways (An editorial stating that though trolley lines are in operation but seven years, there are now over 800 trolley roads. Some recent advances are noticed). Am Eng & R R Jour–Nov. 28. 900 w.

2873. Railroad Racing (An editorial advocating lighter cars as an element toward obtaining higher speeds). Am Eng & R R Jour–Nov 28. 2000 w.

2874. The Most Advantageous Dimensions for Locomotive Exhaust Pipes and Smoke-Stacks. Inspector Troske(Paper read before the German Soc. of Mech. Engs. giving the conclusions of late observations). Am Eng & R R Jour–Nov. 28. Serial. 1st part. 3000 w.

2875. The Docteur Brick-Lined Fire-Box (This locomotive boiler with copper sheet and tubes is used on a Belgian railway, with very satisfactory results. The new brick-lined firebox saved 33⅓% in fuel). Am Eng & R R Jour–Nov. 1700 w.

*2896. Wood Working Machinery for Locomotive Work. W. H. Weston (Showing the advantages to be gained by using various woodworking machines in preference to hand labor. Speed, more perfect duplication of parts, and economy are claimed for the machines). Nat Car & Loc Build–Dec. 1800 w.

*2897. The German Kaiser's Train (A twelve car train costing over half a million dollars. Half tone views of the interior of the private car are given). Nat Car & Loc Build–Dec. 200 w.

*2913. Railroading in South Africa. Philip E. Stillwagen (A practical letter from a practical man. The details of operating, wages, etc. for the Netherlands Railway Co. are given; the road pays an 85 per cent. dividend). Loc Engng–Dec. 2500 w.

†2918. The Lexington Avenue System of the Metropolitan Street Railway Company, New York. Ill. (This line was put in operation on Oct. 13. Its present length is about four and three fourths miles, though it will be extended later to about six miles. The road, which is now run by cable will ultimately be equipped with the underground electric conduit system). St Ry Jour–Dec. 3000 w.

†2919. Power Station Records of the Montreal Street Railway Company (A tabulated statement, with explanation, for the year ending Sept. 1895). St Ry Jour–Dec. 800 w.

†2920. A Comparison of British and American Local Transportation Practice (A table giving the population, tramway mileage, and passengers carried in 19 principal cities in America and England, indicates that in America there is 1500 population to every mile of tramway, while in England there are 7000 per mile in the cities quoted). St Ry Jour–Dec. 1200 w.

†2921. Proposed Electrical Construction of the Metropolitan Street Railway Company, New York (Illustrated description). St Ry Jour–Dec. 1200 w.

†2922. Track Construction without Ties in Toronto (Sections of track are shown). St Ry Jour–Dec. 100 w.

†2923. Brakes on Street Cars (An article arguing that with high speeds, mechanically operated brakes are necessary as the work is too severe for the motorman to perform satisfactorily). St Ry Jour–Dec. 1300 w.

2943. A Simple Electric-Locking Circuit for Interlocked Crossings. N. H. Elliott (Condensed from a paper read before the Railway Signalling Club). Eng News–Dec. 5. 1400 w.

†2958. Interlocking Loop Facing Points (Illustrated description of a new invention). Ind & East Eng–Nov. 2. 1400 w.

†2959. Light Railways and Tramways. R. H. Dorman (A paper read before the Incorporated Asso. of Munic. & County Engs. of Londonderry. The method of construction of such railways in Ireland are fully described). Ind & East Eng–Nov. 2. Serial. 1st part. 2000 w.

2983. New Freight Switching System of the Illinois Central (Description of the method of designating divisions; the switching rules are given in full). Ry Age–Dec. 6. 1300 w.

3001. Reparation under the Act to Regulate Commerce—Opinion and Order of the Commission. The opinion is given in full; also editorial). Ry Rev–Dec. 7. 5700 w.

3002. Snow Shed Fire Protection (A description of the fire trains and the system of preventing and extinguishing fires in Southern Pacific sheds). Ry Rev–Dec. 7. 1700 w.

We supply copies of these articles. See introductory.

SCIENTIFIC MISCELLANY

Injustice to Technical Men.

IN an address recently delivered before the Technical Society of the Pacific Coast, by Mr. Geo. W. Dickie, at an informal meeting held October 5, and reported in part in *American Machinist* (Nov. 7), he divides investigations of natural phenomena into classes,—the "scientific" and "technical." Presumably he means also to range investigators in like manner; this presumption seems warranted by his definition of the adjectives "scientific" and "technical" as applied to investigations.

"Those investigations that are of no immediate use are scientific, while those that have immediate application to some industry, or satisfy some want, are technical." Of course, Mr. Dickie means by investigations effort—experimental or otherwise—systematically and intelligently directed to the finding out of that which is not known, or toward the verification or disproval of previously-announced results or data. A great deal that is called investigation would, under this restriction, be neither scientific or technical, since it is purely and simply misdirected effort. A great deal of such effort has been put forth in attempts to construct a machine capable of self-motion, commonly, but not accurately, called perpetual motion. We suppose an effort of this sort would not be considered by well-educated men either scientific or technical.

Making no quarrel with Mr. Dickie's definition, we pass to the key-note of his address, which is, substantially, that an injustice to technical men is committed by the general public in permitting the scientist to outrank the technician.

"Is it not curious that the world should honor those men whose life-work has no bearing whatever on man's physical requirements or the extent of his resources, and has but little admiration for those whose lives have been spent in devising means whereby the burdens of humanity are lightened. The world places the philosopher in the top row of the scientific benches, while the mechanic is relegated to the lowest forms in the technical class. He who stumbles upon or discovers a new element in some of nature's laws stands infinitely higher in the eyes of the world than the mechanic whose labor has produced work that has lightened the labors of millions of his fellow-men.

"I think this may be taken as a strong proof of the inherent intellectuality of men. Yet, when we consider the fact that the greater part of the world labors under constant and unavoidable necessity of providing itself with daily bread, and never loses an opportunity to protest against the imposition, it would seem that one who seeks to relieve the burden of toil by the invention of labor-saving implements would gain the gratitude of his fellow-men. Yet I do not know that the technical man deserves any better fate than has befallen him. His ambition is of the earth, earthy. He deals with things, instead of with ideas, and therefore gets his reward from things, and not from men. His days are passed in close offices or dreary workshops. He has no delight in nature, except so far as she will help him turn his wheel. He concentrates his whole being within some little trade circle. From dawn to dark the technical man lives and moves and has his being in iron, steel, wood, leather, or whatever other thing he makes or vends, and he often carries these things to his home, to make a technical shop of that sanctuary; tries to make a reputation by discussing them at the Technical Society with other technical people; and is sadly disappointed when the world takes no notice of him."

Now, aside from the question whether a man who investigates the laws of nature simply as a noble intellectual pursuit is not working upon a higher plane than one who seeks to discover something with the sole purpose of putting money in his

purse, let us come to the question of fact raised by Mr. Dickie in his address.

"If the question be asked in a miscellaneous collection of educated men: 'who invented the locomotive?' it is almost certain that George Stephenson would be the name given; and doubt would be expressed, if any one should explain that he only added a little to the labors of others in the same field. Yet amongst that same collection of men it would be a sign of a want of education and culture not to be acquainted with the works of Kepler, Bacon, Newton, Davy, Faraday, Darwin, and many others that have contributed to the sum of human knowledge, but whose work, at least at the time it was done, had but little promise of material help for humanity."

Is it a fact that scientists, pure and simple, are more generally known and honored than technicians? It is true that, as compared with what had been previously done, Stephenson added only a little, but what is little in comparison with some particular standard may be very great when compared with another standard, and the success which Stephenson achieved, demonstrating as it did to the world the practicability of steam locomotion on railway tracks, marks an epoch in the world's progress. It is as true of every scientific advance as it is of Stephenson's locomotive —when viewed from the same standpoint —that it adds but "a little to the labors of others in the same field." The year that has passed has brought to public notice a great discovery,—that of a new atmospheric constituent; but, compared with the labors of others in the study of gases, the composition of air, and of the physical qualities which enable it to be liquefied, the discovery of argon (which will immortalize and ought to immortalize its discoverer) is only a small addition. If air had never been liquefied, in all probability science would yet have remained ignorant of the existence of argon. Anything that any one man, however great, can do or discover must of necessity be a small thing as compared with all that has been done and discovered in that field, or as compared with the entire extent of the field. A man is great, when his work and influence confer public benefits conspicuously above the results of contemporaneous work. Judged by this standard, his work receives honor, and his name becomes famous or otherwise. And this is the only practicable standard by which men, whether their rank be literary, scientific, philosophic, technical, political, or artistic, can be rated.

The work of the rank and file of scientists, though much of it is good, honest, and painstaking, and though it all forms part of what has been done, will be, in the future, as much ignored as that of the technical workers who preceded Stephenson, but who did not produce a successful steam locomotive. The same will be true of the rank and file of technicians. Those whose work towers up will be held in remembrance. In the future record of great men, the names of Westinghouse, Edison, Bell, and Bessemer will as surely find a place as the names of Kepler, Bacon, Newton, and Davy. And among the "ladies of society" and the "miscellaneous collection of educated men" (?) who know little or nothing of the history of the spinning jenny or of the steam engine, we should expect to find the same ignorance of the scientific work which preceded the work of Kepler, Bacon, and Newton, or of the work of these three great men themselves. How many in, say, one thousand of such people could tell us what was the work of these men whom they honor as great, not because they know anything of their work, but because those supposed to know have agreed to call them great?

The Thermophone.

ONE of the best popular descriptions of this new instrument for determining temperature which we have yet seen is given in *Science* (Nov. 15). The following is an abstract.

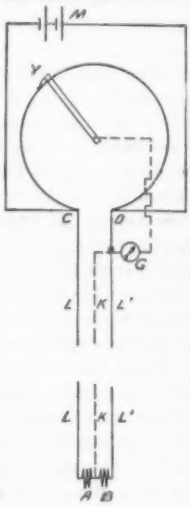
The instrument was invented by Mr. Henry E. Warren and Mr. George C. Whipple, who gave an account of it at the Summer School of Civil Engineering of the Massachusetts Institute of Technology during last summer's session. Since that time its possibilities have been much discussed in scientific circles.

The operation of the thermophone is based upon the principle that the resistance which a conductor offers to the passage of an electric current depends upon its temperature, and advantage is taken of the fact that different metals have different electrical temperature co-efficients. Thus the resistance of a copper wire increases about one per cent. for each 5° F., while in the case of German silver the increase is only about one tenth as great. It is a curious fact that the co-efficients of most pure metals are almost the same as that of copper; but alloys have co-efficients which are much lower.

The arrangement of the electrical parts of the thermophone is shown in Fig. 1. Students of electricity will recognize it as a modification of a Wheatstone's Bridge. Two coils of resistance wires, *A*, *B*, one of which is copper and the other German silver, are made to form two arms of the bridge. These two coils are joined, and placed at the point where the temperature reading is desired. They are usually drawn inside a long brass tube of small diameter, coiled into a helix and hermetically sealed, the space between the wires and the walls of the tube being filled with oil to prevent corrosion and to hasten the transmission of heat between the outside of the tube and the resistance wires. The sensitive coils are connected by the leading wires, *L* and *L'*, to the ends of a circular slide wire, *C*, *D*, and at these points connection is also made with the battery, *M*. A third leading wire, *K*, extends from the junction of the two coils to a movable contact, *V*, on the slide wire. In this circuit there is interposed either a galvanometer or a telephone in connection with a current interrupter, the latter being operated by an independent battery connection. This combination of telephone and current interrupter is used in all the portable forms of the instrument, and has been found to be a very cheap and efficient substitute for a galvanometer. The presence of a current is indicated by a buzzing sound in the telephone; silence corresponds to the "zero deflection" of a galvanometer.

Bearing in mind the principle of the Wheatstone's Bridge, it will be seen that the galvanometer will indicate "zero deflection" when A:B=CY:DY. The coils, *A* and *B*, being made of metals having very different temperature coefficients, will vary in resistance at different rates as their temperature changes, and consequently there will be a different value of the ratio of *A* to *B* for each degree of temperature. Thus it will be seen that, with the bridge balanced, there must be a different position of the contact *V* for every degree of temperature, and a graduated scale may be constructed corresponding to the temperature of the sensitive coils.

The operation of taking a reading with the thermophone is as follows: The helix containing the sensitive coils being placed at the point where the temperature is desired, and the leading wires being connected to the binding posts of the indicator box, the current is turned on, and the telephone held to the ear. A buzzing sound in the telephone is found to increase or diminish as the hand is made to approach or recede from a certain section of the dial. By moving it back and forth, a position may be found where the telephone is silent. When at this point, the hand indicates the temperature of the distant coils. The instrument is extremely sensitive. An inexperienced observer may easily set it to one-tenth of a degree. With special instruments having a small range, it is possible to make readings with much greater precision.



The application of this instrument to the determination of temperature of water at different depths has been entirely successful. The temperatures of water at different points in Lake Champlain have thus been determined and charted. It has

also been found that steel-tape measurements of distance can now be made with great accuracy, the data for corrections for expansion by heat and contraction by cold being supplied readily by the thermophone.

A Romance of Modern Industry.

AN extremely interesting article in *The Iron and Coal Trades Review* (Nov. 15) gives an account of the commercial rise and fall of the Castner process for obtaining aluminum, and of its salvation as a commercial enterprise by a diversion from its original purpose. An abstract of this account is here presented.

Some twelve years ago a young American chemist landed in London with certain ideas as to the possibility of improving the Deville process for the manufacture of aluminum, founded on laboratory experiments that he had made in New York, where he had resided up to that time.

In London he made the acquaintance of distinguished and influential men, who were convinced of the value of the discovery. A company was formed and works erected at Oldbury, near Birmingham, for carrying on the process on a commercial scale. At that time no works were in existence in this country for the manufacture of aluminum on a commercial scale, although the late Mr. Webster had succeeded in cheapening the method then employed for the production of the chlorid of aluminum. The cost of production of aluminum by the Deville process was not less than 40s. per pound, and such aluminum as could be purchased was seldom sold for less than 60s. per pound; but, owing to its high price, and the very limited extent to which it was produced, it was scarcely used in the arts, and such quantities as were available were mainly drawn from France.

Mr. Hamilton Y. Castner, the young chemist referred to, made several important improvements in the Deville process, tending to reduce the cost of producing aluminum from 40s., or more, to about 15s. per lb. The Castner process was based on several reactions: first, the preparation of pure aluminum from alum, bauxite, or clay; secondly, the production of the double chlorid of aluminum and sodium from the alumina prepared in the first operation; thirdly, the production of metallic sodium; and, fourthly, the reduction of aluminum from the double chlorid by the use of sodium. The latter metal, therefore, played a very prominent part in the process, one of the most important features of which was that it gave a practically unlimited supply of a product that was formerly little more than a laboratory curiosity.

The plans were prepared for the erection of the Oldbury works on an extensive scale. At that time there were not more than 50 lbs. of aluminum produced per day in the world; but these works were built of a capacity to turn out 500 lbs. per day, and 1,500 lbs. of sodium, reducing the price of the latter from 6s. to 9d. per pound.

In the third year of the existence of this company it was announced that the Pittsburg Reduction Company had succeeded in reducing alumina by electrolysis, and had thereby brought down the cost of producing aluminum from 15s. to less than 3s. per lb., or, in other words, had reduced the cost of production to about one-fifth of what it was under the Castner patents. The new process consists in passing the electric current through a bath of fluorine, which is kept molten by the heat of the electric arc, between a number of carbon rods and the carbon lining of the vessel, in which alumina, or aluminum oxid, is held in solution. The decomposition of the alumina is thus attained, and electrolysis takes place, with the result of producing pure alumina. Of course, as a method for the production of aluminum, Castner's system was entirely swamped by the electrolytic process, but the process for the production of sodium still remained. At that time, however, there was almost no demand for sodium as such. This demand had to be created. The company laid itself out for doing so, but the work was slow and tedious, and it was not until last year that the company were in a position to announce that the sodium process had so far succeeded as to allow of a dividend being paid on the capital of the company, which had in the meantime been reduced

from £345,000 to £100,000, so as to meet the altered circumstances of the times.

When the aluminum business of the company collapsed, the shareholders were completely discouraged at the prospect of a complete loss to their investments. But Mr. Castner seems to be made of better than the average stuff, and he still sets his face toward progress. Combined with large chemical knowledge and experience, he has ability for original research and great perseverance, and, although it was not in any way due to him that the collapse of his process had occurred, he applied himself to devise ways and means to extricate the Aluminum Company from its difficulties. The special line of research to which he proceeded to devote his attention was the production of caustic soda and bleaching powder by electrolytic methods. Previous experimenters had worked in this field with results that were not at all satisfactory, and the bulk of the caustic soda ash produced in the United Kingdom continued to be produced by the process discovered by Nicolas Leblanc in 1791, which yields both soda and hydrochloric acid, but is more expensive to work than the Solway process, which has become its competitor, and has largely superseded it for soda ash, although not for caustic or bleaching powder. Mr. Castner's experiments led him to adopt as the essential feature of his process a moving body of mercury, which completely separates the products of the electrolysis, and takes the place of a diaphragm, the amalgam formed by the electric action being decomposed electrically as rapidly as it is so formed. The process is a continuous one, and yields an electrical efficiency of between 80 per cent. and 90 per cent. without production of hypochlorites. The process yields by direct evaporation a solid caustic of 99½ per cent. At the Oldbury works the Aluminum Company is said to have now carried on the process for about a year with satisfactory results, on a sufficiently large scale to thoroughly test its value, the plant having a daily output of about 1,200 lbs. of pure caustic soda and 1,000 lbs. of chlorine. The process has now been carried to a point where its further development has become inevitable. The directors of the Aluminum Company have, therefore, made arrangements for erecting large works to prosecute the new industry. These works will come into direct competition with those of the United Alkali Company, which at present may be said to control the production of both caustic soda and bleaching powder in England.

Mildew, Its Causes and Prevention.

THE following abstract from a recent article in the *Boston Journal of Commerce*, reprinted from the *Textile Mercury*, gives information of interest not only to manufacturers, but to users, of textile goods. Mildew stains are the product of a fermentation caused by moisture and heat, whereby fungi are produced which destroy not only the colors, but, by advanced development, the material also. Whenever wet or moist material is allowed to lie for a length of time in a warm temperature, the conditions are established for the development of mildew, especially when the pieces are piled up in heaps, since pressure prevents access of air.

The development of mildew has three distinct phases. The first is that in which the vegetable growth, yet in a rudimentary state, may be removed by energetic washing, or chlorining, without altering the fabrics. In the second stage the fungus growth can no longer be removed; in spite of all that can be done, the stains remain; but the fabric is not weakened. In the third stage, where the growths have acted upon the fabric, the latter is weakened, even burned. The fabric is irretrievably spoiled, and in strongly affected places it is easy to break it by pressure; and the mechanical action of fulling, washing, and giggin produces holes in such places.

Mildew is most frequently found upon gray or white cotton goods, and white or light vat-blue woolens, which are to be dyed in the piece or to be printed; and there it causes the greatest damage by its resistance to the dyes. Even in the dark indigo-blue dyed hoods mildew stains destroy the color, although not so readily and frequently as in light shades of indigo blue.

Less frequently they appear in goods which are dyed upon boiling baths. It appears, therefore, that boiling of the material to a certain extent protects it against mildew, probably because traces of impurities, such as suint, grease, etc., still adhering to the fiber, are thereby either removed or destroyed, and converted into other less injurious bodies. Besides, the mordants employed for other colors than indigo, such as alum, tartar, sulphuric acid, bichromate of potash, green or blue vitriol, etc., probably act as preservatives. The greater tendency of vat-blue dyed goods to favor the development of mildew is doubtless attributable to the fact that the material is not boiled in dying, and to the nature of the dyestuff itself, which promotes fermentation.

Although mildew is quite often found upon dyed and printed goods, it occurs far more frequently upon pieces of goods in the raw condition as they come from the loom or from the fulling mill, unless they are washed without delay. There is nothing more apt to cause fermentation, and consequently the growth of mildew, than the impurities naturally adhering to the fiber, especially to wool, and those which have been deposited upon it in the course of manufacturing. Remnants of suint, of dye-stuff, wool, oil, glue, or dressing, etc., in combination with moisture, contribute materially to heating the goods, so that in sultry weather, if the goods are left in a heap or in some little-ventilated place, twenty-four hours are often sufficient to start the formation of fungi.

Goods treated with weakened solutions are found to be less liable to mildew than those not so treated. Such treatment is common in the manufacture of some kinds of goods, the acid being carefully washed out of the texture and all remaining traces of it neutralized by soda salts. Washed cloth should not be kept for any length of time upon the bottom of a fulling or a washing machine. Neither should it be hung upon wooden supports that have begun to decay, as such supports are likely to contain the spores of the fungus and infect the goods. Generally speaking, cloth made from badly-washed wool, in all stages of its manufacture, is more liable to mildew than that made from thoroughly-cleaned wool.

Hardly less dangerous than sizing in crude material is soap in fulled cloth. It appears that the decomposition of dyestuff and fiber by the soap is a process differing from the actual formation of mould, as if the alkali had a destroying effect in consequence of the heating. In the case of fulled cloth not yet washed, a few hours' storage only is necessary to produce mould spots of larger size and more injurious character than those liable to appear in the crude cloth. For this reason fulled cloth should at once be placed in the washing machine; if this is not possible, it should be washed in the fulling mill.

In order that the woolen manufacturer may protect himself against damage by mould spots, let him, before anything else, see that the cloth, either in a crude or a fulled condition, does not lie longer than is absolutely necessary. Should a delay occur at any time, let him dry the wet places as soon as possible, and not let them accumulate in a wet condition in warm places, drying chambers, etc. Finally, he should guard them from the direct influence of the sun's rays.

When the fiber has not been attacked, mildew can be washed out with soap and water, but, when this fails, resort must be had to chlorid of lime, peroxid of hydrogen, and other bleaching agents.

An Essential for Making Good Bread.

MR. J. B. ALLFREE, in *American Miller* for December, makes, and plausibly sustains, the statement that the best bread possible can be made only from a flour that has its granules of uniform, or approximately uniform, size. He reasons as follows: "Yeast being a plant of the most extraordinary and rapid growth, rapidly setting up in any mass into which it has been introduced conditions similar to its own, it is evident that the impalpable portion of flour will be acted upon speedily, while only the superficial layers of the larger granules would be affected by the ferment. Where such conditions exist,—that is, where the flour granules vary in

size,—the process cannot proceed uniformly. The fine particles cannot wait upon the coarse. They will have passed through the various stages, and too often have reached the acid stage, before the coarser or larger particles will have been more than superficially acted upon. Therefore carbonic acid gas that has been generated by the smaller particles will have been eliminated from the mass, and its usefulness destroyed, while a portion of the nutritive properties will be transformed into this gas and carried away by it. This will materially affect the size of the loaf as well as the flavor and dietetic value of the bread, and, furthermore, from over fermentation, other chemical conditions arise, resulting in discoloration.

"On the other hand, if the flour granules be of even size, this chemical action will be uniform, the entire mass will reach the alcoholic or bread stage at the same time, and, when put into the oven, the heat will stop further fermentation, as well as serving to cook the loaf and further enlarge it by the expansion of the air and the gas contained in it. Thus the nutrient properties are retained, raising the commercial as well as the hygienic value of the bread.

Cost of Haulage on Common Roads.

ENGINEERING NEWS (Dec. 5) prints a statement made by the office of road inquiry in the United States department of agriculture, from which the mathematical and logical conclusion is that the agricultural industry of the United States pays annually about one-third the total value of its products for hauling these products over the common roads to points where they are sold or shipped. The total value of these products was estimated in 1890 at $2,480,170,454, and the total cost of haulage is estimated at $946,414,665. Upon this rather startling statement the following comment is made:

"Certainly, if the figures above given are correct, and if it actually costs a third of the total value of all products of the country's farms and forests to transport them, not to the consumer, but only to the point of shipment by rail or water, the fact is of the greatest economic and industrial importance." This cost, borne wholly by farmers, is double the total earnings of the railways for freights, exclusive of those never carried over common roads, and it largely due to bad roads. Two thirds of it might probably be save by road improvement.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

*2472. An Engineer's Life in the Tropics, Ill. Charles P, Yeatman (Showing the sanitary dangers and physical discomforts attending the work of foreign engineers in South American countries). Eng Mag-Jan. 2800 w.

2475. Practical Advice for the Direct Photographing of Colors According to the Lippmann Method (Full detailed directions for making solutions, preparing the plates, regulating the exposure; description and illustrations of the apparatus, etc.) Sci Am Sup-Nov. 9. 1300 w.

†2512. Comparison in Practice of the Metric and English Systems of Weights and Measures. Arthur Lagron (An argument in favor of the metric system. The discussion by members brought out the difficulties that must be surmounted in introducing it into general practice in the United States). 10th An Rept of Ill Soc of Eng & Surv. 2200 w.

2575. Methods of Measuring High Temperatures. Ill. (An exhaustive review of the subject, containing information obtained from a considerable variety of sources, and noting the advances in the art of pyrometry up to date, with editorial comments). Eng News-Nov. 14. 7500 w.

2582. Electro-thermal Chemistry of Calcium Carbide (A chemical compound of popular interest, usually described under the name of calcium acetylene. An explanation of recent investigations). W. Elec-Nov. 16. 2200 w.

2594. The Thermophone (Illustrated description of a new instrument for, and method of determining temperatures in distant and inaccessible places). Pro Age-Nov. 15. 900 w.

2597. The Thermophone, George Chandler Whipple (A description and explanation of the action of an instrument invented by Henry E. Warren and George C. Whipple, with some account of its varied uses). Science-Nov. 15. 2000 w.

*2634. Eutropy. R. C. Carpenter (The term is defined and its use as applied to the theory of heat engines is explained. A table of the eutropy of water is appended and the subject is further illustrated by diagrams). Sib Jour En-gng Oct. 3300 w.

*2662. The Work of Technical Societies (Editorial review of the origin, spread, and gen-

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eral results of these societies). Engng-Nov. 8. 2700 w.

2691. The Slide Rule and How to Use it. G. D. Snyder (A very thorough exposition of the principles underlying the construction of this instrument and its use, with examples showing its numerous labor-saving applications in scientific and technical work.) Engng News-Nov. 21. 2900 w.

2723. Mildew (Its origin, growth and trouble to cotton and woolen manufacturers). Bos Jour of Cm.-Nov. 23 1300 w.

*2725. A Romance of Modern Industry (A extremely interesting story of the development of the aluminum industry, the ruin of an English enterprise based on the Castner process, by the introduction in America of the electrolytic method of producing metallic aluminum, and the recovery of the fortunes of the company by turning to account the knowledge gained in its abandoned aluminum industry in the manufacture, by a new process, of caustic soda and bleaching powder). Ir & Coal Tr Rev-Nov. 15. 1500 w.

*2738. Double Refraction of Electric Rays. Peter Lebedew (Experiments with technical details). Elect'n-Nov. 15. 3500 w.

2780. Meteorology in the University. Cleveland Abbe (An extract from a report presented in 1893 to President Seth Low, of Columbia College, recommending the establishment of courses in meteorology and a meteorological laboratory in connection with the University). Science-Nov. 29. 2800 w.

†2830. The Temperature Variation of the Thermal Conductivities of Marble and Slate. B. O Peirce and R. W. Willson (Account of an investigation, conducted in the Jefferson physical laboratory, at Cambridge, with refined apparatus and methods, which are described and illustrated with diagrams). Am Jour of Sci-Dec. 1900 w.

†2832. On Some Devices for the Separation of Minerals of High Specific Gravity. S. L. Penfield (Illustrated description of apparatus and methods, and account of some experiments in which these were employed). Am Jour of Sci-Dec. 1100 w.

†2833. How to Find the Key Note of Auditoriums. Ephraim Cutter (The principle of air physics which this method is designed to carry out, is that oratorical phonation should be in the key note of the audience, the oripulations of speech being the same as those of song, and the basic vowels of speech and of song being the same. Directions for ascertaining the key of any auditorium are then given, with a number of examples of its application in different buildings). Am Jour of Sci-Dec. 1100 w.

†2851. Prehistoric Engineering at Lake Copais. John Denison Champlin (An antiquarian research of historical interest, but of little practical import. The ground now occupied by the lake is held to have once been cultivated land, fitted for cultivation by artificial drainage, which was probably effected by natural tunnels. These becoming obstructed were probably reopened. Recent discoveries show that an ancient and complete hydraulic system existed for the drainage of the tract). Pop Sci M-Dec. 4000 w.

†2853. Why the Sea Is Salt. G. W. Littlehales (Maintains that the sea was salt from the beginning instead of slowly becoming so by salts carried into it from the main land in imperceptible quantities as has been supposed by some. Gives chemical and geological reasons for this opinion. A theory of the genesis of oceans is also given). Pop Sci M-Dec. 1600 w.

†2877. Technical Notes on the Gramophone. Emile Berliner (This paper is an elaboration of the system of gramophony, as described by Mr. Berliner, in a previous paper read by him before the Franklin Institute, and published in the Journal. It is illustrated by diagrams and is one of the most attractive scientific papers of the month). Jour Fr Inst-Dec. 5000 w.

*2880. Recent Improvements in Lighthouse Illumination. Ill. (Historical account of improvements since 1822). Nature-Nov. 26. 1700 w.

2886. Night Photography by Electric Light. Ill. Joseph F. Mullander and Sidney Sprout (An account of the researches in this field and the highly satisfactory results). Jour of Elec-.Oto 300 w3.

2925. Recent Improvements in the Sugar Industry. M. L. Lindet (Reprinted from *Jour of the Soc. of Chem. Ind.* Describes improvements in beet sugar industry, which appear to have extended to nearly every operation comprised in the manufacture). Sci Am Sup-Dec. 7. 2000 w.

2927. The Nitrogen of the Air as a Plant Food. George McGowan (The physical and biological principles whereby some kinds of plants are rendered pre-eminent as absorbers and storers of nitrogen, which, if they are left to decompose in the earth become food for other plants having this power in less degree). Sci Am Sup-Dec. 7. 3200 w.

2941. The Cost of Hauling Freight on Common Roads (Abstract from a Dept. of Agriculture Report, giving the results of the investigations and further information contributed editorially). Eng News-Dec. 5. 2200 w.

*2953. The Superior Bread-Making Qualities of Evenly Granulated Flour. J. B. Allfree (The general principles of bread-making in relation to the quality of flour used in it). Am Miller-Dec. 1500 w.

*2966. The Metre System of Weights and Measures (A deputation representing 46 Chambers of Commerce, waited upon Mr. Balfour, to urge the desirability of adopting the metric system of weights and measures. Abstract of remarks made by the committee and Mr. Balfour's reply). Nature-Nov. 28. 4000 w.

2980. A Plea for Better Protection of Life and Property. Christopher Clarke. Suggestions of plans of protection and prevention resulting from years of study of the subject of reducing loss by fires in buildings). Fire & Water-Dec. 7. 800 w.

*2988. Approximate Calculations. A. H. Barker (Short methods for simple operations to obtain closely approximate results). Prac Eng-Nov. 29. 1500 w.

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Wilkins and Davison, Engineers, Pittsburgh, Pa., U. S. A.=Engineering Views, being twenty-four elegant plates in half-tone, of bridges, water works, engine houses, and other structures erected from designs of this firm.

Nutting Truck Works, Faribault, Minn., U. S. A.=Catalogue and price list of new and standard styles of platform and handle trucks—2-, 4- and 6-wheeled, for handling goods and materials in factories, warehouses, etc. 22 pp.

Edward Smith & Co., New York, U. S. A.=Pamphlet, entitled "Application of Paints, Varnishes and Enamels for the Protection of Iron and Steel Structures and Hydraulic Work." Contains an interesting essay on this subject, describes the paint made by this firm and presents testimonials confirming its value.

Davis Heater Co., Racine, Wis., U. S. A.=Pamphlet, 16 pp., describing steam and hot water heaters for warming buildings.

Beaman & Smith, Providence, R. I., U. S. A.=Catalogue, D, 63 pp. Illustrating and describing an extensive list of machine tools manufactured by this firm.

Fort Wayne Electric Corporation, Fort Wayne, Ind., U. S. A.=Large and elegant catalogue of electrical machinery and apparatus for light and power. (The Wood Systems) 132 pp.

The Billings & Spencer Co., Hartford, Conn., U. S. A.=Large and elegant catalogue, illustrating and describing electric railway and trolley specialities, commutator segments, machine shop tools, and drop forged goods in variety.

The Long & Allstatter Co., Hamilton, Ohio. U. S. A.=Catalogue No. 18, 88 pp., illustrating and describing an extensive line of punching and shearing machinery. Over 350 sizes and styles, for all kinds of punching and shearing in metal by power, are catalogued.

The Weir Frog Co., Cincinnati, Ohio, U. S. A.=Catalogue, 273 pp. A list of frogs, switches, crossings and all kinds of regular and intricate track work and material, for steam railways, electric railways, cable roads, horse-car lines, and portable track-work, for mines, contractors, plantations, etc.

The Correspondence School of Technology, Cleveland, Ohio, U. S. A.=Instruction by mail in electrical engineering, steam engineering, bridges, roofs and iron structures, surveying and road construction, mechanical engineering, hydraulic engineering, and advanced mathematics.

Robinson Electric Truck and Supply Co., Boston, Mass., U. S. A.=Illustrates and describes the Robinson radial system of car trucks, with diagrams illustrating the difference in action of this truck from that of other car trucks, testimonials, etc.

W. J. Johnston Co., New York, U. S. A.=Catalogue, 48 pp. Electrical Books.

United States Metallic Packing Company, Philadelphia, U. S. A.=Catalogue and price-list, 26 pp. Stuffing-boxes, locomotive packings, stationary and marine engine packings, metallic packings, lever-lock mechanism, lubricators, oil cups, portable drilling machines, etc.

Bird Paper Manufacturing Co., New York, U. S. A.=Samples, bound in book form, of three grades of water-proof building and insulated paper.

Pen Argyl Iron Works, Pen Argyl, Pa., U. S. A.=Catalogue, 60 pp., 7" × 10". [Describing and illustrating a line of high-grade hoisting machinery for mines, quarries, pile driving, bridge building, and general construction work.]

American Boiler Co., New York and Chicago, U. S A.=Partial list of users. [Forty-five feet of references, confidently believed to be the largest list of steam and hot-water heater consumers ever printed. The company estimates that the names which appear in these lists are only about one-half the actual number of users of their heaters. The lists are printed in a continuous roll, making a very striking exhibit.]

Dwight Slate Machine Co., Hartford, Conn., U. S. A.=Catalogue, 1895. [Describes and illustrates an extensive line of machine tools.]

The Lidgerwood Manufacturing Company, New York, U. S. A.=Pamphlet (in press) "Travelling Cableways, and Some Other Devices Employed by the Contractors on the Chicago Drainage Canal." [This book will be one of the well-known sketch-book series, same size as the previous issues, containing 72 pages, and 36 full-page illustrations, intended particularly to illustrate the multiplicity of uses to which the Lidgerwood hoisting engine can be applied. The travelling cableways, twenty of which have been sold and used on the Chicago Drainage Canal, occupy the larger part of the book, which may be had, free of cost, on application to the company at 96 Liberty street, New York city.]

A. D. Quint, Hartford, Conn., U. S. A.=Catalogue, 20 pp. Quint's turret drills.

Babcock Printing Press Co., New London, Conn., U. S. A.=Catalogue, 32 pp., describing and illustrating printing presses.

Gesholt Machine Co., Madison, Wis., U. S. A.=Catalogue, 44 pp., illustrating and describing turret lathes, screw machines, monitor, gap and chucking lathes, and universal tool grinders.

Robb Engineering Co., Amherst, N. S.=(a) Pamphlet, 38 pp., illustrating and describing the Robb-Armstrong Engine. (b) Pamphlet 16 pp, illustrating and describing this engine direct connected to dynamo.

American Balance Slide-Valve Co., San Francisco, Cal., U. S. A.=Pamphlet illustrating and describing the "American" balance slide valve.

Prentiss Vise Co., New York, U. S. A.=Catalogue and price list of vises with cuts and descriptions.

Frick Company, Waynesboro, Pa., U. S. A.=Catalogue, 107 pp., describing and illustrating engines, and boilers, including the "Eclipse" Corliss Engine.